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ISSUED BY THE AUTHORITY OF THE CHIEF SECRETARY FOR QUEENSLAND, THE HON. W. FORGAN SMITH, LL.D.

CRUSTACEA BRACHYURA FROM THE COASTS OF QUEENSLAND.*

BY MELBOURNE WARD, F.R.Z.S., F.Z.S., HONORARY ZOOLOGIST AUSTRALIAN MUSEUM, HONORARY COLLECTOR QUEENSLAND MUSEUM.

(Plates I—III.)

Super-Family BRACHYRHYNCHA.

Family GONOPLACIDAE Dana.

CRYPTOLUTEA gen. nov.

CRYPTOLUTEA LINDEMANENSIS Orthotype.

Type locality, Lindeman Island, Whitsunday Passage, Queensland.

Generic description. — The carapace is moderately convex longitudinally; transversely flat. The fronto-orbital width is more than half the width of the carapace. The antero-lateral margins are arcuate but unarmed. Postero-lateral margins are parallel. The eye stalk is as long as the antennulary fossa, fitting snugly into the orbit. Basal article of the antenna does not reach the front. The epistome is smooth and slightly concave and of equal proportions throughout its extent. The buccal frame does not widen anteriorly. The space between the external maxillipeds is filled by the palpi. The antero-lateral angle of the merus of the external maxilliped is rectangular and not at all prominent. Chelipeds are unequal, but not markedly so. The third legs are longer than the others by half the length of the dactylus. The masculine abdomen is narrower at the base than the sternum and all seven segments are free.

CRYPTOLUTEA LINDEMANENSIS sp. nov.

(Pl. I, figs. 1, 2, 3.)

The carapace is three-quarters as long as it is broad. The surface is smooth; there is no indication of regions except for the depressions separating the cardiac from the gastric. Lank hairs are scattered over the surface and form thick fringes along the margins and front, effectively concealing the eyes from a dorsal view. The vertical walls of the carapace, composed of the epimeral and anteriorly of the sub-hepatic and pterygostomian regions, are smooth and hairy only on the posterior third.

The palms of the chelipeds are unequal in the males. The merus is hidden beneath the carapace, the upper border has a strong tooth near the distal extremity. The carpus is smooth and compressed, its inner angle blunt, granulated and clothed with a dense fringe of scraggy brown hairs; this fringe extends along the anterior margins.

* The types are housed in the Queensland Museum, Brisbane.

The palm of the larger cheliped is smooth on the surface with a few well marked punctae; near the lower border is a row of small sub-spinate granules, their points directed towards the pollex; on the pollex is a shallow groove in which a line of coarse punctation may be seen. The small palm resembles the larger except for the more developed groove on the pollex.

In the females the chelae are equal in size; the lower part of the outer surface of the palm of both is more granulated than in the male.

Relationships.—*Cryptolutea lindemanensis* bears a superficial resemblance to *Speocarcinus luteus* McNeil, Port Stephens, N.S.W., but differs in the form of the external maxillipeds, in the form of the fingers of the larger cheliped, being shorter and thicker in *lindemanensis*; in the short palm of *lindemanensis*. The cornea of the eye of *C. lindemanensis* is not visible from a dorsal view.

Material.—Six males ranging from 7-15 mm., in greatest breadth of carapace. The type is 16 mm. broad.

Ten females ranging from 6·5 to 16 mm. greatest carapace width.

Habitat.—All the material here recorded came from a region on the western side of Lindeman Island where stones lie partially buried in mud. At low water this region does not drain off completely, so that on turning over a stone, a pool quickly forms where the stone had lain. *Cryptolutea* excavates intricate burrows under the stones, extending from one to the other at an inch or two below the surface of the mud.

PRONOTONYX nom. nov.

Pronotonyx lævis (Miers) Orthotype.

Type Locality, Arafura Sea, 32 fms.

Pronotonyx differs from the related *Notonyx* A. M. Edwards, New Caledonia, in all the characters enumerated below :—

Carapace broader than long, smooth and shining. Front more than one third the width of the carapace. A strong tooth on the upper border of the merus of the cheliped. The merus of the external maxilliped has the antero-lateral angle auriculated. The anterior margin of the buccal frame is entire. The basal segment of the masculine abdomen almost reaches the coxi of the fifth pair of ambulatory legs.

PRONOTONYX LÆVIS Miers.

(Pl. I, figs. 4, 5, 6.)

Ceratoplax laevis Miers, Zool. Alert, Crust., 1884, 244. Dredged 32-36 fms. Arafura sea.

The species occurs in deep water in the vicinity of Lindeman Island where I have dredged it on mud.

Material.—Two males measuring 9 and 9·5 mm., in maximum carapace width. Three females measuring 7·5, 8, 8·5 mm., in maximum carapace width. The female measuring 8 mm., has an immature abdomen and is infested by the Rhizocephalid barnacle *Thomsonia sp.*

Family Xanthidae Alcock.

PSEUDOCRYPTOCŒLOMA gen. nov.

Orthotype **PSEUDOCRYPTOCŒLOMA PARVUS** sp. nov.

Type Locality, Lindeman Island, Whitsunday Passage, Queensland.

Generic Description.—Carapace three-quarters as long as it is broad. The posterior portions of the carapace are flat, smooth and shining. The epistome is twice as wide as it is long. The anterior margin of the buccal frame is raised and has an obsolete fissure on each side. The merus of the external maxilliped has the antero-lateral angle sub-auriculate. The buccal frame is completely filled by the external maxillipeds.

PSEUDOCRYPTOCŒLOMA PARVUS sp. nov.

(Pl. I, figs. 7, 8, 9.)

The posterior and median portions of the carapace are flat, smooth, shining and devoid of hair. Fringes of long shaggy hairs cross the front, eyes, hepatic regions and antero-lateral margins. The chelae and ambulatory legs are similarly fringed with long hairs. The front is equal to one third of the breadth of the carapace. The antero-lateral margins are arcuate and slightly shorter than the postero-lateral margins and are obscurely dentate.

The basal article of the antenna fills the orbital hiatus. The antennules are large, the fossæ take up the entire under surface of the front.

The chelae are broad and compressed, sub-equal. The merus is hidden by the margin of the carapace; the carpus has a broad sharp angle, the outer surface smooth and covered with hair. The upper margin of the palm is granulated under the fringe of hair, the outer and inner surfaces are smooth, the margin is sinuous. The pollex is broad and bent slightly below the outline of the palm; the dactylus is bent sharply downward proximally; the prehensile edges of both fingers have a few teeth proximally and both tips acuminate. There is a strongly developed line of punctæ parallel with and close to the lower border extending from the tips of the pollex to the middle of the palm; this is more marked in the smaller cheliped.

The ambulatory legs are long and slender, their upper borders lined with thick fringes of hairs, becoming more dense on the distal articles. The sternal surface is smooth and polished.

Material.—Twenty-eight males measuring from 6 mm. to 10·5 mm. maximum carapace width. Twenty-six females measuring from 6 mm. to 10 mm. maximum carapace width. The type is a male measuring 10 mm., in maximum carapace width.

Habitat.—The species occurs under stones on mud at about half way down the intertidal area.

Relationships.—Pseudocryptocœloma differs from *Cryptocœloma* in the following characters :—

Pseudocryptocœloma.	*Cryptocœloma*
The eyes are visible from a dorsal view.	The eyes are hidden below the margins of the front.
Ant. lat. margins of carapace lined with hairs of unequal length.	Ant. lat. margins of carapace lined with short thick fringe from which arise long flexible hairs.
Exposed surface of carapace is smooth and polished.	Exposed surface of the carapace is dull, uneven and sculptured on the branchial regions.

Pseudocryptocœloma differs from *Heteropilumnus* De Man in the form of the chela, in the entire margin of the carapace, in the development of the posterior margin of the carapace which is wider than that of *Heteropilumnus.*

Genus **CHLORODOPSIS** A. M. Edwards.

Chlorodopsis A. Milne Edwards, Nouv. Archiv. Mus. Hist. Nat. Paris, ix, 1873, 227. Ward, Australian Zoologist, vii, iii, (15 Sept.) 1932, 250.

CHLORODOPSIS MIERSI nom. nov.

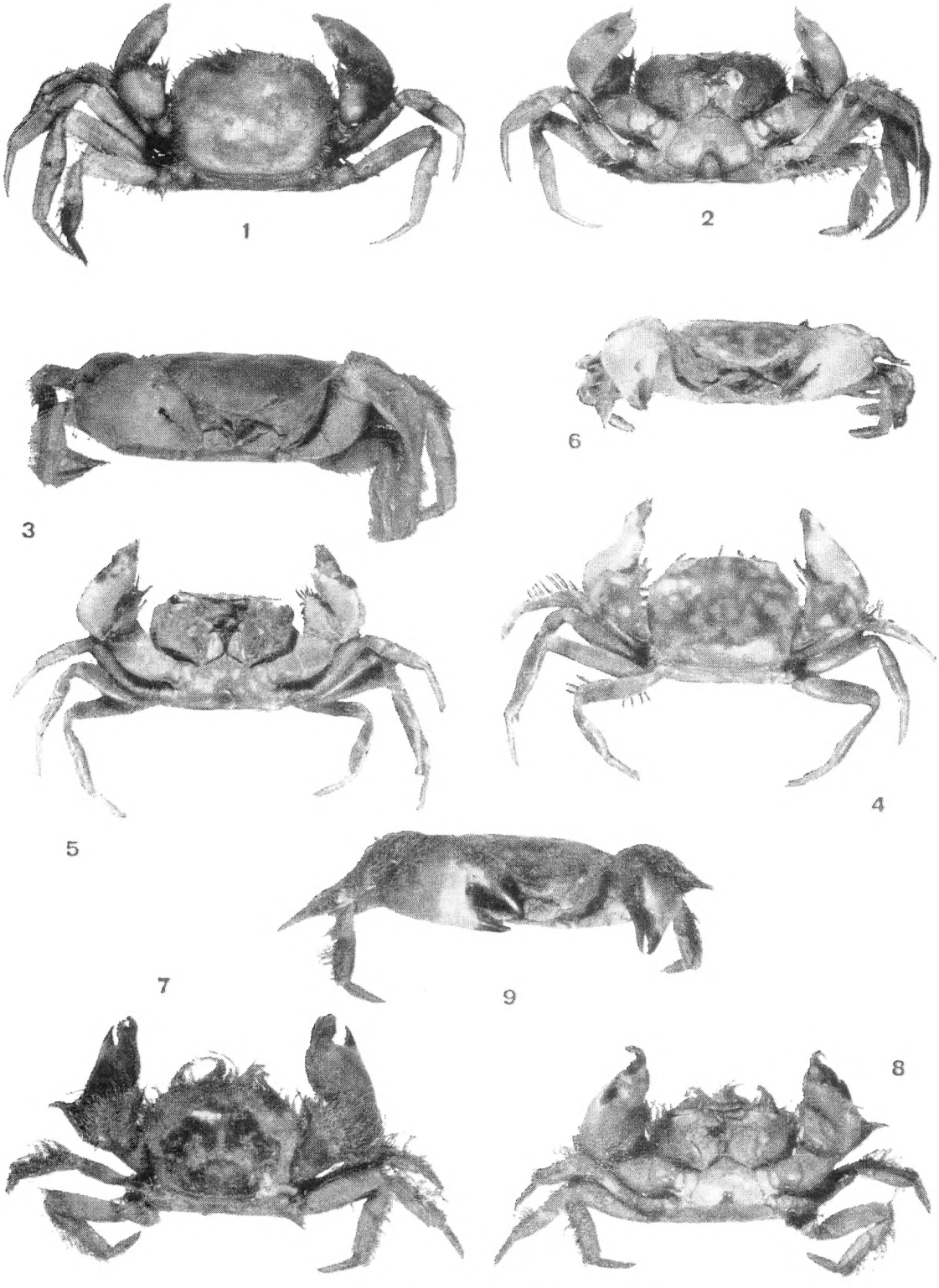
Chlorodopsis granulatus Miers (nec. Stimpson) Zool. Alert, Crust., 1884, 216. Pl. xxi, fig. A., Port Denison, Port Molle.

(Pl. II, figs. 1, 2, 3.)

I have a mature male of *Chlorodopsis granulatus* Stimpson from Singapore, and the following notes on the Australian species are based upon this specimen and one of similar proportions from Lindeman Island, Queensland.

1. The eyes fit the orbits completely in *miersi.*
2. The process on the base of the antenna is joined to the upper angle of the orbit, not joined in *miersi.*
3. The dark colour of the palm almost covers the whole surface in *C. granulatus.*
4. The lobes of the front are more produced in *C. granulatus.*
5. The pubescence of the carapace is different, being of a uniform length in *miersi,* while there are some longer hairs on the lateral portions in *granulatus.*

Material.—Thirty-two males ranging from 7 to 17 mm., maximum carapace width ; twenty-three females ranging from 8·5 to 15 mm., maximum carapace width.



Queensland Crustacea.—Melbourne Ward.

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Genus **ETISODES.**

Etisodes Dana, Sillimans Amer. Journ. Sci. and Arts (2), xii, 126 (footnote), Pro. Philad. Acad. Nat. Sci., 1852, 77 ; and U.S. Explor. Exped. xiii I, 1852, 185. Type *E. frontalis* Dana, Sooloo Sea.

In 1932 I recorded *Etisodes* Dana as a sub-genus of *Etisus* A. M. Edwards ; since then I have examined considerably more material and have come to the conclusion that *Etisodes* should be considered a distinct genus.

ETISODES AUSTRALIS sp. nov.

(Pl. II, figs. 4, 5, 6.)

Type locality.—Lindeman Island, Whitsunday Passage, Queensland.

The carapace is broader than long. The dorsal surface is flat posteriorly, slightly convex anteriorly. The inter-regional sulci are moderately developed ; the areolations are finely granulated, the granules tend to form short transverse lines, there are a few hairs on these ridges. The antero-lateral margins are arcuate, quadridentate, each tooth procurved and its margin granulated.

The upper margin of the orbit is broken by two fissures, a third deeper one below the external angle ; the lower margin is entire.

The flagellum of the antenna does not enter the orbit, there is a prolongation of the basal article which fills the orbital hiatus.

The antennulary fossæ are large, square. The epistome is smooth and restricted. The sub-hepatic and pterygostomian areas are granulated and tomentose.

The external maxillipeds fill the buccal frame. The ischia are smooth and polished, the meral articles are finely granulated ; few golden hairs on the anterior margins of the maxillipeds. The sternum is polished and sparsely punctate.

The masculine chelae are sub-equal, the merus projects beyond the edge of the carapace ; the carpus is very rugose, crossed by fine lines of granules which tend to become squamiform and there is a short, sharp spine on the inner angle. The manus is compressed and as broad as the superior margin is long, squamose above, becoming smooth towards the lower margin. The pollex is deep and has two ridges on the outer surface ; the dactylus is strongly curved, meeting the pollex only at the tip, both are strongly spoon-excavated. The smaller chelae has the manus and fingers long and narrow. The brown colouration extends back on to the palm from the pollex.

The ambulatory legs are slender, hairy and have the upper margins of the last three articles ornamented with sharp granules.

Material.—The type is a male measuring 12·5 mm., maximum carapace width.

Fifteen males ranging from 8·5 to 16·5 mm., maximum carapace width. Three of these are parasitised by Rhizocephalid barnacles, *Sacculina*. Eleven females ranging from 10 mm., to 41 mm. maximum carapace width. Six of these are infested by *Sacculina*.

LEPTODIUS.

Leptodius A. Milne Edwards, Ann. Sci. Nat. (4), xx, 1863, 284. Ward, Australian Zoolog. vii, iii, 1932, 244. Type *L. exaratus* (H. M. Edwards).

LEPTODIUS AUSTRALIS sp. nov.

(Pl. II, figs. 7, 8, 9.)

Type locality, Lindeman Island, Whitsunday Passage, Queensland.

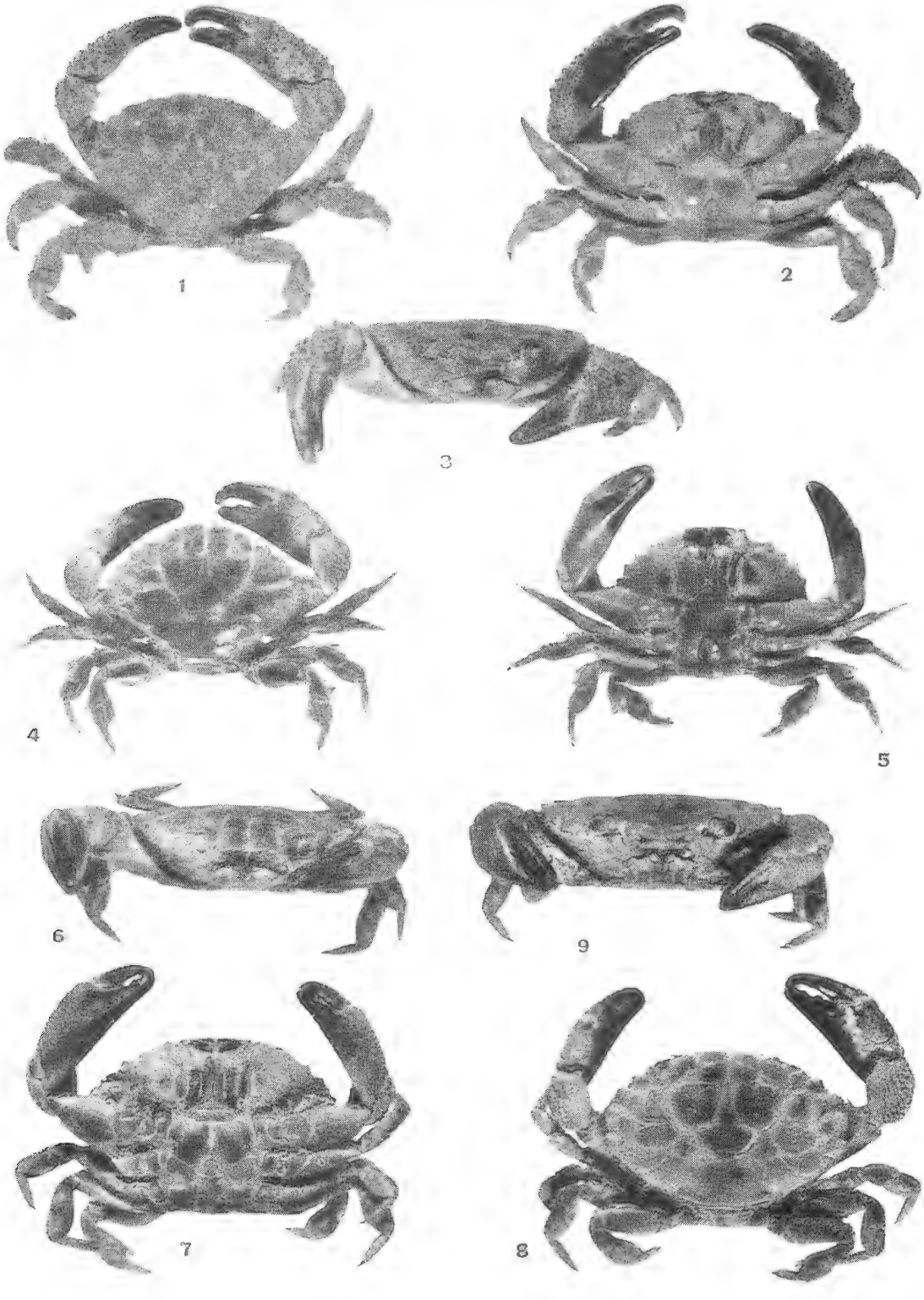
The carapace is broader than long, very distinctly areolated; flat posteriorly, anteriorly convex, the surface is granulated anteriorly, the hepatic region has two elevated granular areas near the margin, the sub-hepatic regions are granulated and the epimeral walls of the carapace are clothed with long hairs. The upper margin of the orbit has two obsolete fissures and both margins are granulated. The antennular flagellum occupies the orbital hiatus. The antennules lie transversely. The epistome is narrow. The external maxillipeds completely fill the buccal orifice; the merus is granular, the ischium smooth and punctate. The sternum is finely granular and shining.

The chelae are unequal; the merus projects beyond the edge of the carapace, the carpus is coarsely granulated with an acuminate inner angle. The manus is coarsely granulated above, smooth at the lower border; the dactylus and pollex meet only at their tips.

The distal articles of the ambulatory legs are coarsely granulated. The proportions of the carapace, also the form of the teeth of the antero-lateral margins and the greater development of granules, separate *australis* from the other species on the Australian coast.

Material.—Fifteen males ranging from 11·5 to 19 mm. maximum carapace width. Sixteen females ranging from 9 mm. to 15 mm. maximum carapace width. Type male 13 mm. maximum carapace width.

Four other species have been recognised from the coast of Queensland—*L. sanguineus* H. M. Edwards, Isle de France, *L. exaratus* H. M. Edw., Coasts of India, *L. nudipes* (Dana) Mangsi Island, L. *crassimanus* A. M. Edw., New Caledonia.



Queensland Crustacea.—Melbourne Ward.

Face page 6.

So far as my own field experience is concerned the species of *Leptodius* enumerated are localised in their occurrence on the coast. *L. sanguineus* and *L. nudipes* are characteristic of the outer coral reefs, *L. exaratus*, *L. crassimanus* and *L. australis* are found on the mainland and the shores of the mainland islands. Each species is limited to certain definite regions in a given locality. Hence we find *L. exaratus* under stones from just below high tide level down to the end of the boulder zone which is approximately the limit of the neap lows. *L. crassimanus* inhabits a boulder zone below low tide on rocky shores which slope downward and do not merge into a coral reef formation. *L. australis* inhabits a narrow belt of rocks at neap low-tide level.

L. sanguineus is found under masses of beach rock conglomerate on coral cays such as the Capricorn Group, and *L. nudipes* inhabits the Lagoon Zone where it hides under loose masses of coral.

BANAREIOPSIS gen. nov.

Banareiopsis australis sp. nov. Orthotype.

Type locality, Lindeman Island, Whitsunday Passage, Queensland.

Generic description.—The length of the carapace is equal to three-quarters of the breadth. The front is equal to approximately one fifth of the carapace breadth. The antero-lateral margin is long and curved and composed of four broad teeth separated by deep and narrow fissures; those between the first, second and third teeth are continued as deep grooves over the sub-hepatic regions, becoming linked up as one groove extending parallel with the margin of the carapace. This formation enables the crab to remove poisonous slime of its host, *Sarcophyton* sp., from the water which is drawn down the grooves, and the accompanying slime is caught by the thick coat of bristles which covers the grooves.

Banareiopsis differs from *Actaea* De Haan in the formation of the external maxillipeds, the antennules and by the large size achieved by mature individuals. From *Banareia* A. M. Edw., by the more globose form of the carapace, the triangulate hiatus between the ischia of the external maxillipeds and the large size of the mature individuals.

BANAREIOPSIS AUSTRALIS sp. nov.

(Pl. III, figs. 1, 2, 3.)

The carapace is strongly convex; the surface is areolated, the inter-regional sulci are deep and smooth, the areolae are coarsely granulated. The orbits are small and deep, the margins thick; there are two fissures above and one at the external angle; the lower margin is deeply curved to form

two coarsely granular lobes. The basal antennal article fills the orbital hiatus, leaving a narrow space which connects with the deep sub-hepatic groove. The front is poorly developed and formed into four small rounded teeth which barely cover the antennules. The antennules are folded very obliquely, the basal article of the antenna forms the lateral part of the antennulary fossæ.

The chelae are equal in size and capable of close application against the sub-hepatic regions of the carapace; the merus is compressed the upper surface concave and with shallow grooves which resemble those on the sub-hepatic regions of the carapace; the upper margin is sub-acute and has a broad, blunt tooth near the distal extremity. The carpus is as long as the merus, measured along the upper margin; the outer surface is areolated by shallow smooth sulci and the areolae are granulated. The manus is slightly compressed, the upper margin is broadly rounded and granulated; these granules spread over the upper half, becoming fewer towards the lower margin. The dactylus and immovable finger are blade-like; their tips cross when closed.

The ambulatory legs are short and thick and capable of being closely drawn together in flexion.

The whole animal is covered with a dense coat of short bristles, and tufts of longer and more flexible hairs are situated on the areolae of the carapace.

Material.—One female measuring 44·5 mm., in maximum carapace width, designated as type.

Twenty females ranging from 24·5 to 40·5 mm., maximum carapace width. Sixteen males ranging from 24·5 to 40·5 mm., maximum carapace width. The mature females differ from the males in being thicker through the body; the abdomen is broad, covering nearly the whole of the sternum. The size at which maturity is achieved by the females is not fixed; there are four specimens 26, 27, 29 and 30 mm., broad which have abdomina almost as narrow as the male, there are two others, 24·5 and 28 mm., which have mature abdomina and another 32·5 has an abdomen of intermediate size.

Super-Family OXYRHYNCHA.

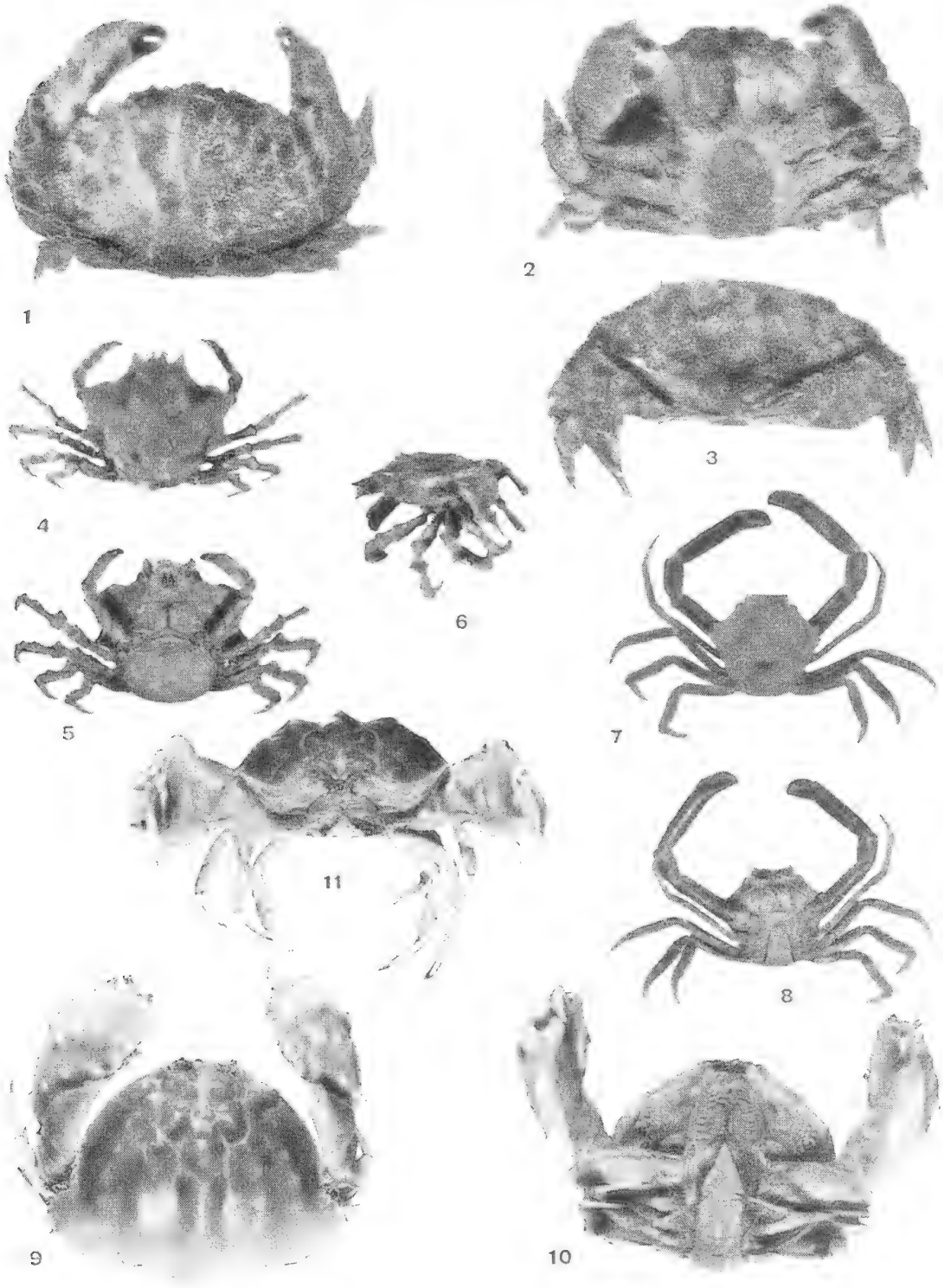
Sub-Family Acanthonychinae Alcock.

SARGASSOCARCINUS gen. nov.

Orthotype *Sargassocarcinus foliatus* sp. nov.

Type Locality, Lindeman Island, Whitsunday Passage, Queensland.

Generic description.—The lateral margins of the carapace are produced into petaloid processes, which are not divided as in *Huenia* De Haan. The



Queensland Crustacea.—Melbourne Ward.

Face page 8.

rostrum is bifid and steeply deflexed. There is no post-ocular spine. The eyes are fixed in the orbits. The supra-ocular eave is produced into a large flattened spine resembling the rostral spine.

The ambulatory legs are sharply carinated.

SARGASSOCARCINUS FOLIATUS sp. nov.

(Pl. III, figs. 4, 5, 6.)

The carapace is broader than long, flattened; the surface is irregular and covered with fine tomentum which imparts a punctate appearance. Three low elevations form a triangle on the posterior portion of the gastric region, the apex directed posteriorly. The posterior margin of the carapace is carinate, its lateral angles acute.

The basal articles of the antennae are broad; the flagella stand in the orbital hiatus between the rostral and supra-orbital spines and are visible in dorsal view. The antennulary fossæ are long and narrow. The epistome is well developed and smooth. The margins of the buccal frame are faintly carinated except at the antero-lateral angles which are distinctly carinate. The external maxillipeds completely close the buccal orifice, the merus is much shorter than the ischium and has the lateral angle truncated. The surface of the sternum near the maxillipeds is moderately excavated. The development of the chelipeds varies in the sexes. Those of the mature male, 10 mm., maximum carapace width, are massive and compressed and all the margins are carinated; the dactylus is trigonal, the upper margins are carinated, the intervening surfaces are concave. The fingers meet only at the tips when closed and there is a single tooth on the prehensile surface of the dactylus proximally.

Sargassocarcinus foliatus differs from *Mimulus cristatipes* Balss, Sagamibai, in the proportions of the carapace, and the relative dimensions of the fronto-orbital region.

Material.—One female 8 mm., maximum carapace width, designated as type. Four females ranging from 8.5 to 10·5 mm., maximum carapace width. Four males ranging from 7·5 to 10 mm. maximum carapace width.

Family PARTHENOPIDAE Alcock.
Sub-Family EUMEDONINAE Miers.

HARROVIA Adams and White.

Zool. Voy. Samarang, Crust., 11, 1849, 55.

Holotype, *H. albo-lineata* Adams and White.

Since the original description of the typical species, the following have been described.

Harrovia elegans de Man, Journ. Linn. Soc. London, xxii, 1888, 21, pl. 1, figs. 5 and 6. Elphinstone Ild., Mergui Archipelago.

Harrovia tuberculata Haswell, Proc. Linn. Soc. N.S.W., iv. 1880, 455, pl. xxvii, fig. 1. Darnley Island.

The type is extant in the Macleay Museum in the University of Sydney.

Harrovia albolineata var. *longipes* Lanchester, Proc. Zool. Soc., London, 1900, 729, pl. xliv, fig. 8. Singapore.

Harrovia japonica Balss, Zool. Anzeiger, v. 52, 1921, 177.

Harrovia purpurea Gordon, Mem. Mus. Royal d'Hist. Nat. Belgique, 1934, 67. Sorong, New Guinea.

HARROVIA PLANA sp. nov.

(Pl. III, figs. 7, 8.)

The carapace is broader than long, dorsal surface convex and with two low elevations transversely placed but without granules or tubercles; the whole carapace is covered with a dense coat of pubescence. The rostrum is truncated, declined and divided into four teeth, two median and two narrow lateral ones which are produced slightly beyond the median pair. The antero-lateral margin is quadridentate, the last two are developed into salient triangulate teeth, the first two are equal in size, granulated, inconspicuous, and occupy the greater part of the margin. The eyestalk not enlarged and the cornea is globose.

The chelipeds are approximately one sixth longer than the carapace; the merus is granulated, as long as the manus measured along the lower margin; the manus is slightly thicker than the merus.

The ambulatory legs are reduced in length towards the fifth pair which are the thickest. The chelae and legs are free of tomentum.

Harrovia plana differs from *Harrovia albolineata* Ad. & White as figured by Gordon, 1934, in the shape of the eyestalk and cornea and in the form of the antennae and the rostral lobes.

Material.—One male measuring 6.5 mm., maximum carapace width designated as type. One female 9 mm., maximum carapace width.

Type Locality, Lindeman Island, Whitsunday Passage, Queensland.

Habitat.—The species occurs as a commensal upon a Crinoid inhabiting reefs below low tide mark.

OXYSTOMATA.

Family CALAPPIDAE Alcock.

Sub-Family CALAPPINAE Alcock.

Genus **CALAPPA** Weber.

Calappa Weber, Nomenclator entomologicus, 1795, 92.

Logotype, *C. granulata* Weber 1795. Specified by Latreille, 1810, Mediterranean.

CALAPPA TERRAE-REGINAE sp. nov.

(Pl. III, figs. 9, 10, 11.)

Type locality, Lindeman Island, Whitsunday Passage, Queensland.

The carapace is broader than long and strongly convex. Five longitudinal rows of smooth pustulous nodules, the three median rows are more developed than the two lateral ones; the surface of the carapace is finely punctate, especially in the anterior half.

The postero-lateral eaves of the carapace are smooth, the margins dentate and finely granulated; the posterior margin of the carapace is armed with small teeth, the two median are more produced than the others.

The front is bidentate and produced slightly beyond the outer angles of the orbits. There are two closed fissures in the upper margin of the orbit. The orbital hiatus is filled by the antenna. The afferent branchial canal ends below the eye as a simple rounded process which forms the lower orbital border. The antennules fit into fossæ which lie obliquely under the frontal teeth.

The outer surface of the chelipeds is smooth to the unaided eye, but under a lens appears finely venous, the veins extending vertically. This is most developed towards the lower border. The upper half is finely granulated. The upper border is armed with six teeth. Three rows of pearly bosses are disposed in obliquely vertical lines, the median row is the most developed. A fourth row extends parallel with and slightly above the lower border finishing before the pollex is reached. In the larger cheliped the massive tooth on the outer surface of the pollex is almost square, coarsely granulated, these granules form a triangulated patch, the base of which is a little above the lower border, fills the space between the lower border and the fourth row of bosses. The tooth on the outer surface of the dactylus which is opposed to the tooth on the pollex is short and rounded at the tip. The dactylus is compressed and blade-like and strongly curved downwards. In the smaller cheliped there is a low boss covered with granules on the outer surface of the pollex. Both palms have three rows of granules along the lower borders; the outermost is the

most complete, extending from the tip of the pollex to the blunt tooth near the articulation with the carpus. The median row does not reach the tooth and the third row is faint and curved up on to the inner surface of the palm. The external surface of the carpus is produced into a tridentate carina, the teeth of which are blunt and ornamented with a thick fringe of long soft hair.

The females are mature at 33·5 mm. carapace width (not including the postero-lateral eaves). There are three strongly developed teeth on the second segment of the female abdomen.

Material.—Type female 33·5 mm. carapace width.

Relationships.—Calappa terrae-reginae is related to *Calappa lophos* (Herbst)[1] but may be readily separated by the following characters. The carapace of *C. terrae-reginae* is narrower than *C. lophos* (Herbst), being almost as long as wide (not including the postero-lateral eaves), whereas *C. lophos* is three-quarters as long as it is broad. The fronto-orbital region of *C. lophos* is distinctly more produced anteriorly and the frontal teeth are acuminate; the frontal teeth of *C. terrae-reginae* are broad and blunt. The orbital hiatus is broader in *C. lophos* than in *C. terrae-reginae*, and the afferent canals end in three projecting teeth.

The posterior margin of *C. lophos* is armed with six slender acuminate spines; in *C. terrae-reginae* there are nine small teeth.

EXPLANATION OF PLATES.

PLATE I.

Cryptolutea lindemanensis.

1. Dorsal view of the type measuring 16 mm. in maximum carapace width. Lindeman Island, Whitsunday Passage, Queensland.

2 and 3. Ventral and frontal views of same.

Pronotonyx lævis (Miers).

4. Dorsal view of a male measuring 9.5 mm. in maximum carapace width. Lindeman Island, Whitsunday Passage, Queensland.

5 and 6. Ventral and frontal views of same.

Pseudocryptocœloma parvus.

7. Dorsal view of the type, male, 10 mm. in maximum carapace width. Lindeman Island, Whitsunday Passage, Queensland.

8 and 9. Ventral and frontal views of same.

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[1] *Calappa lophos* Herbst is an Indian species of which I have material from the Hooghli River, kindly forwarded to me by the Indian Museum.

PLATE II.

Chlorodopsis miersi.

1. Dorsal view of type, male, measuring 15 mm. maximum carapace width. Lindeman Island, Whitsunday Passage, Queensland.

2 and 3. Ventral and frontal views of same.

Etisodes australis.

4. Dorsal view of type, male, measuring 12.5 mm. in maximum carapace width. Lindeman Island, Whitsunday Passage, Queensland.

5 and 6. Ventral and frontal views of same.

Leptodius australis.

7. Ventral view of type, male, measuring 13 mm. maximum carapace width. Lindeman Island, Whitsunday Passage, Queensland.

8 and 9. Dorsal and frontal views of same.

PLATE III.

Banareiopsis australis.

1. Dorsal view of type, female, measuring 44 mm. maximum carapace width. Lindeman Island, Whitsunday Passage, Queensland.

2 and 3. Ventral and frontal views of same.

Sargassocarcinus foliatus.

4. Dorsal view of type, female, measuring 8 mm. maximum carapace width. Lindeman Island, Whitsunday Passage, Queensland.

5 and 6. Ventral and lateral views of same.

Harrovia plana.

7. Dorsal view of type, male, measuring 6.5 mm. maximum carapace width. Lindeman Island, Whitsunday Passage, Queensland.

8. Ventral view of same.

Calappa terræ-reginæ.

9. Dorsal view of type, female, measuring 33.5 mm. carapace width. Lindeman Island, Whitsunday Passage, Queensland.

10 and 11. Ventral and frontal view of same.

DESCRIPTIONS OF NEW RATS AND MICE FROM QUEENSLAND.

By E. Le G. Troughton, Zoologist, Australian Museum.*

An impression formed when preparing a paper describing five new species of *Pseudomys* (*sensu lato*)[1] that many yet remained to be discovered, hitherto unnoticed because of shy habits and the tendency to accord far too extensive ranges to individual forms, has received confirmation in a collection recently submitted for identification by the Director of the Queensland Museum.

This interesting murine material was collected by Mr. F. L. Berney, recently President of the Royal Australasian Ornithologists Union, near the homestead of his property known as Barcarolle, on the Thomson River, 135 miles south of Longreach, central Queensland. The homestead is on a reddish sand ridge which is fairly heavily timbered, and the remarkable similarity of colouring shown by the representatives of three distinct genera suggests that the general surroundings exercise a decided influence on the local fauna. Fortunately several years preservation in formalin, which is not suitable for mammals, does not seem to have affected coloration very much.

Of the eighteen specimens one represents a new race of *Notomys*, seven a new race of *Pseudomys* (*sensu stricto*), while ten mice represent a very distinct and unusually coloured species of *Gyomys*, with which the collector's name is gladly associated as a small tribute to his keenness as a naturalist, which has resulted in many helpful donations to both the Queensland and Australian Museums.

A general review of the Australian Museum material also brought to light a new species of *Gyomys* from the Rockhampton district, the smallest known for the genus according to two specimens collected by my colleague Mr. Anthony Musgrave. Also of considerable interest was the identification of a specimen and odd skull of *Leggadina patria* from the Gladstone district, thereby greatly extending the range of the small coastal species from the original locality of Inkerman in the Townsville area.

It is notable that the elevation to generic rank of the four subgenera of *Pseudomys*, initiated in the Check-List of Mammals in 1934, becomes even more desirable with the description of additional forms, which raise to thirty the known total of species and geographical races for the original genus.

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* By permission of the Trustees.

[1] Troughton.—Records Austr. Museum, xviii, 6, 1932, pp. 287-294.

Regarding the subgeneric divisions, Finlayson has stated that the manner of their construction by Thomas suggested a merely temporary expedient. On the contrary one finds that the author not only nominated a type and provided a comparative diagnosis of each sub-division but listed the appropriate species as well, the only tentative feature being the hesitation expressed by Thomas in leaving several very diverse species under the same generic heading.

Although the diagnostic characters are naturally variable or less marked in some instances, a combination of dental and cranial features will invariably relegate individual species to their respective divisions. The generic value of these divisions is strikingly illustrated in the description of *Gyomys desertor* Troughton (*loc. cit.*) of Central Australia, which authors had previously confused with the Western Australian *Thetomys nanus* Gould because of the close external resemblance.

In 1934 Brazenor[2] listed the previously known species of the *Gyomys* "group" as four but he omitted the earliest species, *novæhollandiæ*, and also *desertor* described in 1932, while including the geographical race of *albocinereus*. Description of the two small forms below raises the known total of full species of the group to eight, providing a range of size and coloration which renders generic distinction essential to a systematic or popular comprehension of the several groups comprising the original super-genus *Pseudomys*.

GYOMYS BERNEYI sp. nov.

Diagnosis.—A medium-sized rather short-tailed species, of an unusually warm yellowish-brown for the genus, the tone above nearest that of *novæhollandiæ*, from which it is distinguished by its sharply contrasted entirely white belly fur, relatively shorter tail, and longer molar row. Dimensions and coloration distinguish it from all others of the genus. *Habitat*: Barcarolle Station, 135 miles south of Longreach, Queensland.

Colour.—Above, about Clay Colour to Tawny-Olive (Ridgway), composed of the Ochraceous-Buff fur-tips with their pencilling of Sepia, becoming clearer on the sides, and a Pale Yellow-Orange on the cheeks and belly-edge, contrasting sharply with the entirely white fur of the underparts. Ears Sepia to Clay toned outside, white-haired within. Manus white, with a wash of Pale Yellow-Orange extending down the arm and over wrist. Pes white, a yellowish wash extending over the proximal fourth. Tail brownish above, dull white below. Female somewhat paler in tone, more drab buff on the centre of back, with Light Pinkish Cinnamon edging the belly and also contrasting sharply with the white undersurface.

[2] Brazenor.—Mem. Nat. Mus. Melb., viii, 1934, p. 159.

External characters.—Fur of medium length and density, that of the back averaging 8·5 and the long pile about 10·5 mm. Ear of medium length but broad, reaching within 2 mm. of posterior canthus of eye when pressed forward. Pes comparatively short and broad, the length varying less than 1 mm. in a series of ten young to adult specimens of both sexes. Tail proportionately the shortest in the genus.

Skull and dentition.—Skull rather lightly built, with a low dorsal profile, short narrow rostrum, and very light zygomatic arches. Palatal foramina extremely long and narrow, longer than in all species excepting the much larger-skulled *glaucus* and *fumeus*. Nasals shorter than in all species excepting *pumilus*. Incisors very slender and narrow. Upper molar row much lighter than in *desertor*, slightly longer than in *glaucus*, definitely longer than in *novæhollandiæ*, and much longer than in *apodemoides*.

Dimensions of holotype male.—Wet specimens (female in brackets); head and body 95·5 (99·5); tail 63·5 (61·5); pes of both 19 × 3·6; ear 13·5 × 10·3 (14 × 11·5) mm.

Skull: greatest length 25·5; basal length 22·3; zygomatic breadth 14·1; nasals 8·2 × 2·5; interorbital width 3·6 (3·9); breadth braincase 12; palatal length 13·9; palatal foramina 5·8 × 1·2 (5·4 × 1·4); upper molar row 4·6; breadth of m^1 1·5; bulla length 5·2, breadth including meatal tubercle 5.2 mm.

Habitat.—Timbered sand ridge country on Barcarolle Station, 135 miles south of Longreach, central western Queensland.

Typical series.—Seven males and three females, the holotype and three paratypes in the Australian Museum, Nos. M.6000-3, and six paratypes in the Queensland Museum, where the series was originally sent by the collector, Mr. F. L. Berney.

Remarks.—This very distinct, brightly coloured small species, is distinguished from all other *Gyomys* by the sharply contrasted dorsal and ventral coloration and short tail, and by having shorter nasals than all but the smallest species (*pumilus*), while the palatal foramina are decidedly longer than in any species with skulls of similar size. Of the general appearance, Mr. Berney noted that "It is a short-faced and wide-jawed mouse, with a stumpy tail which looks as if each individual had lost half an inch of the tapering end."

GYOMYS PUMILUS sp. nov.

Diagnosis.—Smallest known for the genus and nearest *novæhollandiæ* in coloration, but clearly distinguished from it by the much shorter hindfoot, ear, and molar row. *Habitat.*—Byfield, 25 miles north of Yeppoon, near Rockhampton, coastal Queensland.

Colour.—General colour of the back of the female holotype sandy-brown, nearest a light or buffy Sayal Brown, composed of the Cinnamon-Brown and Warm Buff tipping, becoming clearer on the rump and sides, with an ochraceous wash on the nose and below the eyes. Undersurface Olive-Buff, somewhat paler on the throat where the fur is uni-coloured. Basal fur above and below a shade of greyish-brown, sharply contrasting with the pale tips. Front of ear conch Prout's Brown, richer than the rest of the body coloration. Manus, pes, and tail buffy white.

External characters.—Fur soft and rather long, about 7 mm. in the middle of the back. Ear relatively long, surpassing the posterior canthus of the eye when pressed forward. Pes in two adult females the shortest known for adults of the genus (16·3-16·7), the measurement of 16 mm. given for *G. albocinereus* apparently referring to immature females. Tail of medium length, equalling that of the much larger short-tailed *berneyi*, but much shorter than in adult *novæhollandiæ*.

Skull and dentition.—The skull is definitely the smallest and lightest known for the genus, the cranium though rather broad in comparison with the narrow nasal region being quite transparent. Edge of zygomatic plate straight. Palatal foramina relatively very broad (4 × 1·5), their breadth equalling that of the larger *berneyi* (5·5 × 1·5 mm.). Bullæ small and transparent. Upper molar row quite proportionate, but naturally the smallest of the genus, the length being 3·5 as compared with 3·8 in *apodemoides*, and 4·1 mm. in the nearer allied *novæhollandiæ*.

Dimensions of holotype.—Adult female in spirit: head and body 68; tail 61; pes 16·7; ear 11 × 8·5 mm.

Skull: greatest length 20·8; basal length 16·8; zygomatic breadth 11; nasals 7·2 × 2; interorbital width 3·4; breadth braincase 10·2; palatal length 10·3; palatal foramina 4 × 1·5; upper molar row 3·5; breadth of m^1 1; bulla length 3·6, breadth including meatal tubercle 4 mm.

Habitat.—Byfield, 25 miles north of Yeppoon, near Rockhampton, coastal south Queensland.

Typical specimens.—Adult female holotype and paratype, Nos. M. 6032-3, collected and presented in 1924 by Mr. Anthony Musgrave F.R.E.S., Entomologist to the Australian Museum.

Remarks.—I am indebted to my old friend and colleague, Anthony Musgrave, for the opportunity of describing this tiny and delicately coloured species, which has the distinction of being the smallest indigenous mouse known to occur in Australia or the adjacent islands. It is also most interesting

as probably representing a northern form of the rare type of the genus, *novæhollandiæ*, which does not appear to be represented in any Australian museum and has not been recorded since Gould, in his Mammals of Australia, referred to Waterhouse's type, described from Yarrundi on the Upper Hunter River in 1843, as somewhat immature, and recorded additional specimens from the same district, and others secured on the banks of the Gwydir River by his collector Gilbert.

As the late Oldfield Thomas stated in correspondence, there is no doubt that many specimens marked *novæhollandiæ* in museums are merely so named because they came from the New Holland of the early days, while no doubt the apparent rarity of the species is partly due to the fact that country observers would naturally associate the animal with the introduced house mouse which is frequently found in the paddocks and bush.

There is, however, no doubt of the distinction of the much smaller *pumilus*, both in comparison with Gould's figures of the natural size, and in the paler tail and more yellowish underparts, as well as in the smaller cranial and dental measurements contrasted with the greatest length of 25, breadth of 11·5, and molar row of 4·1 mm. given for *novæhollandiæ* in correspondence by Oldfield Thomas.

LEGGADINA PATRIA Thomas and Dollman.

Mus patrius Thomas and Dollman, Proc. Zool. Soc., 1908 (April, 1909), p. 791.

It is interesting to note of this small coastal Queensland species, which has not been recorded since its original description from Inkerman near Townsville in 1909, that examination of the collection some years ago revealed a spirit specimen listed No. 41 in the earliest register of the Australian Museum, and an odd unregistered skull. These specimens, collected at Warroo on the shores of Port Curtis, near Gladstone, by F. A. Blackman, who also presented collections of shells from that district, do not differ markedly from the original description and they therefore indicate a considerable extension of range southward for about 400 miles.

Returning down the east coast from an expedition to north Australia in the winter of 1934 I had hoped to investigate reports of a plague of mice in the Bowen area, but unfortunately the road conditions at the time necessitated an inland detour from Townsville to Rockhampton. In view of the above extension of range, however, there seems little doubt that the reports referred to this small indigenous species.

Strangely enough, no examples were received amongst the series of over 150 rats of several species, from north and south of Townsville, recently

submitted for examination by the Director-General of Public Health in connection with the investigation of Weil's Disease, and by the Colonial Sugar Refining Company in regard to economic loss on the cane fields. Fortunately, however, the little animal is probably too small to cause damage to the sugar-cane or contend with its larger relatives, so that there is every reason to hope that the species may never become a serious danger to health or produce.

PSEUDOMYS MINNIE FLAVESCENS subsp. nov.

Diagnosis.—A buffy to umber toned race lacking the Pinkish Cinnamon wash of the typical form, and with the fur longer and less dense and the feet and tail more coarsely haired. Dimensions generally similar though averaging somewhat larger, the nasal region and zygomatic arches more heavily built, and the bullæ definitely larger. Habitat: Barcarolle Station, 135 miles south of Longreach, Queensland.

Colour.—General colour of back, in a male and two females, ranging from light yellowish to umber brown, replacement of the Pinkish Cinnamon tone of the typical race with buffy tones being responsible for the characteristic yellowish coloration. The lighter female allotype has the dorsal colour composed of Ochraceous-Buff pencilled with Clove Brown, while the darker holotype male has a mixture of clay colour and blackish brown. The head as usual is lighter, and the buffy wash clearer on the sides, which are not strongly contrasted with the buffy white belly tips, through which the dark grey basal fur is seen. Fore and hind limbs washed with bright buff and manus and pes white. Tail brown above, contrasting with the white sides and undersurface.

External characters. — Pelage finer, sparser, and much longer than in the typical race, the main pile averaging 13 instead of 10 mm., and the manus, pes, and tail are longer and more coarsely haired. Dimensions decidedly variable but ear definitely broader than in typical *minnie*.

Skull and dentition.—Dimensions generally similar but the skull more stoutly built, with stronger zygomatic arches, more arched dorsal profile, and a much deeper rostral region, and decidedly larger bullæ than in the typical form. Dentition similar.

Dimensions of holotype male.—Wet specimen (female in brackets): head and body 120 (133); tail 103 (115); pes 30 (29·3); ear 23 × 17·5 (23·5 × 17) mm.

Skull: greatest length 30·7 (32); basal length 27·2 (28·6); zygomatic breadth 16·2 (16·6); nasals 11·3 × 3 (12·7 × 3·2); interorbital width 3·8 (4);

breadth braincase 14·2; palatal length 16·6 (17·4); palatal foramina 7·5 × 2·1; upper molar row 5·7 (5.8); breadth of m^1 1·9 (2); bulla 5·3 × 5·9 (5·6 × 5·9), the breadth including meatal tubercle.

Habitat.—Timbered sand ridge country on Barcarolle Station, 135 miles south of Longreach, central western Queensland.

Typical series.—Three males and four females, the holotype skin and skull and two paratypes, Nos. M. 6004-6, in the Australian Museum, and four paratypes in the Queensland Museum where the specimens were originally sent by the collector and donor, Mr. F. L. Berney.

Remarks.—The richer coloration and more robust build of this central Queensland race apparently reflects the less arid habitat with its richer more heavily timbered sand ridges. The yellowish instead of greyish tone, longer pelage, coarsely haired feet and tail, and broader ear, associated with the larger and more elevated bullæ, readily distinguish it from the typical race of north-eastern South Australia.

NOTOMYS ALEXIS REGINÆ subsp. nov.

Diagnosis.—Colour and dimensions generally much as in typical *alexis* and gular region quite similar, the colour above somewhat more yellowish and the sides differing in being sharply contrasted with the whitish underparts, much as in *Ascopharynx cervinus*. Skull distinguished by the much narrower interorbital region, smaller nasals, and smaller and more transparent bullæ. Habitat: Barcarolle Station, 135 miles south of Longreach, Queensland.

Colour.—Generally lighter than in typical *alexis*, much as in *A. cervinus*, about Cinnamon Buff pencilled with Clove Brown above, the clearer cinnamon of the sides and limbs making a sharply contrasted line with the whitish underparts, the fur of which shows only a faint trace of grey basally instead of the definite grey band seen in typical *alexis*; manus and pes similarly whitish but tail with the brush not so long or so dark brown above.

External characters.—Gular area as in *alexis*, not strongly haired anteriorly as in *mitchelli*, or definitely lipped as in *cervinus*. Compared with specimens of typical *alexis*, measured personally in the field, the young adult male in spirits, has the ear and pes relatively shorter. Interdigital pads of pes distinctly broader and widened out distally in comparison with the pads of typical *alexis*, the pads being waisted instead of evenly ovate.

Skull and dentition.—The skull generally more lightly built, and, though the dimensions tend to intergrade, the interorbital region is definitely much narrower in the young holotype, a notable feature as the region usually narrows

with age, while the nasals are relatively narrower, the palatal foramina wider, and the bullæ are smaller and more transparent than in topotypical specimens of the original *alexis*. Incisors more slender, and much more orthodont, and molar row smaller, than in true *alexis*.

Dimensions of holotype.—Young adult male in spirit: head and body 91; tail 117; pes 29·5; ear 19 × 12 mm.

Skull: incomplete basally; zygomatic breadth 13; interorbital width 4·6; nasals 10·4 × 2·6; palatal length 14·5; palatilar length 12·7; palatal foramina 5·2 × 1·8; upper molar row 4·8; breadth of m^1 1·8; bulla, length 5·9, breadth including meatal tubercle 6·2 mm.

Habitat.—Timbered sand ridge country on Barcarolle Station, 135 miles south of Longreach, central western Queensland.

Holotype.—Young male, skin and incomplete skull, in the Queensland Museum collection, numbered 54 in the collector's list of the donor, Mr. F. L. Berney.

General Remarks.—In Brazenor's recent Revision of the Jerboa Mice[3] some confusion of status and range is indicated by the relegation of *Ascopharynx fuscus* to the synonymy of *Notomys alexis*, and the untenable suggestion that *alexis* is synonymous with the geographically distant *aquilo* of Cape York. The range of *alexis* is given as barely reaching the South Australian border, whereas *fuscus* was described from about Ooldea on the Trans-Australian Railway, so that were the two forms identical an enormous almost coast to coast range should have been shown for the single species.

As indicated in the Check List, according to my examination of a large series, *fuscus* is actually synonymous with *cervinus*, as both the character of the gular pouch and the coincident range suggest. The typical *fuscus* has a similar gular pouch to *cervinus*, present in both sexes, and inclusion of its characters therefore renders Brazenor's description of *alexis* misleading, at least in regard to the variable nature of the gular region. Topotypes of *alexis*, collected by myself at Alexandria Downs, show no trace of folds of skin forming a pouch, while the original notes of Thomas merely referred to the "indication" of a glandular organ on the throat.

The new race agrees with the typical form of *alexis* in the simple structure of the gular area but is well differentiated otherwise. Owing to the immaturity of the only specimen, and the incompleteness of its skull, it seemed advisable to regard it as a subspecies only, though an adult series would probably exhibit characters warranting specific distinction.

[3] Brazenor.—Mem. Nat. Mus. Melb., viii, 1934, pp. 74-89, pls. v-vii.

In regard to Brazenor's suggestion that *alexis* is doubtless a synonym of *aquilo*, it may be pointed out that, quite apart from the difference in incisive index and belly colour, his list of dimensions actually shows the holotype of *aquilo* to possess a greater head and body length and correspondingly longer hindfoot, with which is contrasted a definitely smaller ear.

Furthermore, the suggested continuous distribution of the two forms is negatived by the fact that the unique specimen of *aquilo* evidently came from the apex of the Peninsula and not "the dry areas south of Cape York," as it was collected in the 'sixties by Cockerell with his base at Somerset. Even if the range on Cape York was fairly considerable there is a river system, and much country inhospitable for the genus, forming a barrier to any recent continuity of geographical range for the two species.

As Thomas originated both forms after comparing the material it is reasonable to assume that examination of the holotype of *aquilo* would further emphasize the differences indicated above, and *alexis* must be regarded as definitely distinct in regard to characters as well as distribution.

MORE ICHTHYOLOGICAL MISCELLANEA.

By Gilbert P. Whitley, Ichthyologist, The Australian Museum, Sydney.*

(Plate IV, and Text-figures 1-6.)

The present paper may be regarded as a continuation of the "Ichthyological Miscellanea" which appeared over five years ago in these Memoirs (vol. x, pt. 1, 1930, p. 8). In that contribution a review of the work on Queensland ichthyology enabled those interested to maintain up to date the list of Queensland fishes published in 1925 (These Memoirs viii, p. 125). Nowadays, one is confronted by so many additions and alterations that the time is ripe for a revised list.

In the past decade an increasing number of collecting parties have visited the Great Barrier Reef, including the British expedition of 1928-29, a report on whose Fishes appeared in 1932. The present writer has been associated with several of these parties and has examined many hundreds of freshly caught and therefore correctly localized specimens. In this period he has collected at North-West Islet (1925), Michaelmas Cay (1926), Low Isles (1929), North-West Islet again (1931), and Lindeman Island to Bowen (1935), besides securing, during his holidays, specimens for comparison from Rarotonga (1931), Western Australia (1933) and various islands of the Pacific during recent cruises. He has been greatly assisted by his friend, Mr. Melbourne Ward, who made large fish collections at Heron Island (1926), the Bunker Group (1927), Torres Strait (1928), Hayman Id. (1928), Port Curtis and the Capricorns (1929, three trips), North-West Islet (1930), Papua (1933), and Lindeman Island, where he secured about 400 specimens during his term, just concluded, as Resident Naturalist, and where we together secured over one thousand specimens of elasmobranchs and fishes last year. Mr. F. A. McNeill, of the Australian Museum, has made several trips to the Cumberland Group and secured some remarkable species. Messrs. Hale and Tindale, of Adelaide, made a collection of fishes in Princess Charlotte Bay which was reported upon in Records of the South Australian Museum, v, 3, 1935, p. 345. A further British Expedition is promised at no distant date. All this field work has resulted in additional knowledge of the distribution and relative abundance of many Queensland fishes.

Turning to publications, apart from those already referred to, it is to be noted that Dr. N. A. Borodin, in the Bulletin of the Vanderbilt Museum, i, 1932, p. 69, lists a number of Queensland fishes collected by Mr. W. K. Vanderbilt on his world-cruise in the *Alva* during 1931-32. Mr. Fraser-Brunner

* Contribution from The Australian Museum.

(Ann. Mag. Nat. Hist. (10) xiii, 1934, p. 465) described a new snake eel from Queensland, and Mr. J. R. Norman (Proc. Zool. Soc. Lond. 1935, p. 99) mentions several of our Lizard-fishes. Papers dealing with taxonomy and nomenclature have appeared in these Memoirs, in the Australian Zoologist, and the Records of the Australian Museum, in recent years. The North Queensland Naturalists' Club, with headquarters at Cairns, now issues a small publication, in which fishes have been recorded. Cases of sharks attacking man in Queensland have been detailed by Dr. V. Coppleson in the Medical Journal of Australia for April 15, 1933.

Further welcome contributions to our knowledge of the Queensland Lungfish have been made by Longman, Bancroft, and Rudel in the Memoirs of the Queensland Museum and the Proc. Linn. Soc. N. S. Wales, whilst our smaller freshwater fishes are receiving more attention from aquarists, who are critically differentiating the various species. A preliminary account of the Devil Ray (*Daemomanta alfredi*) has appeared in The Australian Museum Magazine, vi, 1936, p. 4.

The works on Indo-Pacific fishes by Fowler, Giltay, Weber and Beaufort, Herre, and others, issued in recent years, are of importance to the study of our tropical species.

Once again it is my pleasing duty to thank the Queensland Museum officials for facilities for study granted to me on my visits to Brisbane. Mr. T. C. Marshall has identified a number of interesting species and has unreservedly placed his notes at my disposal. Amongst others, he has listed :

I. 5153 *Trygonorrhina fasciata* M. & H. [New rec. Qld.] Off Cape Moreton, S. Qld. (W. R. Howard).

I. 5205 *Anyperodon leucogrammicus* C. & V. Rib Reef, Townsville (G. Coates). [New record for Australia].

I. 5212 *Cephalopholis urodelus* C. & V. Flat Rock, S. Qld. (W. R. Howard). [New rec. Austr.]

I. 5257 *Epinephelus areolatus* Gmelin. Rib Reef, Townsville, Nth. Queensland (G. Coates). [New rec. for Australia].

I. 5291 *Epinephelus summana* Bonn. Cairns (N. Qld. Nat. Club).

I. 5259 *Epinephelus cyanostigma* C. & V. Rib Reef, Townsville, Nth. Queensland (G. Coates). [New rec. Australia].

I. 5293 *Sparus berda* Gmelin. Cairns (N. Qld. Nat. Club).

I. 5178 *Scolopsis bimaculatus* Ruppell. [New rec. Qld.] Cairns.

I. 5297 *Chætodon rainfordi* McCulloch. Noosa Beach (R. A. Cresdee).

Family CLUPEIDAE.

Sub-Family HYPERLOPHINAE.

Genus **HYPERLOPHUS** Ogilby, 1892.

HYALOSPRATTUS, subg. nov.

Orthotype, *Hyperlophus translucidus* McCulloch.

Differs from true *Hyperlophus* in the advanced situation of the anal fin, with corresponding skeletal modifications, and in coloration.

HYPERLOPHUS (HYALOSPRATTUS) TRANSLUCIDUS McCulloch.

Hyperlophus translucidus McCulloch, Rec. Austr. Mus. xi, 7, Feb. 20, 1917, p. 165, pl. xxix, fig. 3. Sans Souci, Botany Bay, New South Wales. Holotype and paratypes in Austr. Mus. *Id.* McCulloch, Austr. Zool. ii, 1921, p. 16 and Austr. Mus. Mem. v, 1929, p. 40.

Mr. H. S. Mort collected a specimen, 38 mm. in standard length, belonging to this species, when gathering shells on Caloundra Beach, south Queensland, early in June, 1935. Previously it had only been known from the Sydney district, New South Wales.

New record for Queensland. Austr. Mus. regd. no. IA. 6451.

Family SYNGNATHIDAE.

Genus **SOLEGNATHUS** Swainson, 1839.

SOLEGNATHUS FASCIATUS (Gunther).

Solenognathus fasciatus Gunther, Rept. Voy. Challenger, Zool. i, 6, 1880, p. 30, pl. xiv, fig. B. Off Twofold Bay, N. S. Wales. Type in British Museum. *Id.* Waite, Proc. Linn. Soc. N. S. Wales (2) ix, 1894, p. 227, pl. xvii, figs. 6 & 9.

Solegnathus fasciatus Waite, Mem. Nat. Club N. S. Wales ii. 1904, p. 19. *Id.* McCulloch, Zool. Res. Endeav. i, 1911, p. 27 and Austr. Zool. ii, 2, 1921, p. 28, pl. ix, fig. 99c. *Id.* Lord, Proc. Roy. Soc. Tasm. 1922 (1923), p. 64. *Id.* Lord & Scott, Verteb. Anim. Tasm. 1924, p. 40. *Id.* Whitley, Rec. Austr. Mus. xv, 1927, p. 293. *Id.* Scott, Proc. Roy. Soc. Tasm. 1933 (1934), p. 39.

A dry specimen (Austr. Mus. regd. no. IA. 6562) was found washed ashore at Lindeman Island, Queensland, by M. Ward ; a record which considerably extends the known range of this species, which was hitherto known only from New South Wales southward to Tasmania.

Family MELANOTÆNIIDAE.

LOMANETIA, gen. nov.

Orthotype, *Melanotœnia multisquamata* Weber and Beaufort, Fish. Indo-Austr. Archip. iv, 1922, p. 290, from the Idenburg River, north New Guinea = *Lomanetia multisquamata*.

Mouth-opening with a very slight downward curve, when viewed from front : jaws equal. More than twenty-four predorsal scales and thirty-seven or more scales on the lateral line. Base of anal fin longer than distance from origin of first dorsal to end of second. Pectorals not as long as head, but much longer than head without snout.

Family EPINEPHELIDAE.

Genus **EPINEPHELUS** Bloch, 1793.

EPINEPHELUS HOEDTII (Bleeker).

Serranus hoedtii Bleeker, Nat. Tijdschr. Ned. Ind. viii, 1855, p. 406. Amboina, East Indies.

Epinephelus hoedti Bleeker, Atlas Ichth. vii, 1875, p. 45, pl. cclxxxiii, fig. 2 (plate published 1870).

D. xi/16 ; A. iii/8 (9). Brown, with many small dark brown spots, also a dark " moustache " mark ; margins of vertical fins narrowly edged white.

Localities.—One, 18 inches long, from Goat Island, Moreton Bay (F. W. Moorhouse) ; Qld. Mus. regd. no. I. 5194. Another 13 inches long from Bulwer, Moreton Island (G. Wise) is I. 5240. This species is also known from New South Wales.

Family APOGONIDAE.

FODIFOA, gen. nov.

Orthotype, *Foa fistulosa* Weber.

Differs from the true *Foa* notably in having a subcutaneous tube on each side posteriorly like that developed in *Adenapogon* and *Siphamia*, and which Weber considered was a hydrostatic apparatus.

FODIFOA FISTULOSA (Weber).

Foa fistulosa Weber, Notes Leyden Mus. xxxi, 1909, p. 162. Sumbawa, East Indies. *Id.* Weber, Siboga-Exped., Fische, 1913, pp. 235, 237 & 244-247, pl. x, fig. 6, and text-fig. 57. *Id.* Weber & Beaufort, Fish. Indo-Austr. Archip. v, 1929, p. 352, fig. 82. *Id.* Whitley, Great Barr. Reef Exped., Sci. Rept. iv, 9, 1932, p. 284.

One specimen (Austr. Mus. regd. no. IA. 6832) was trawled off Shaw Island, Cumberland Group, in about 10 fathoms, on September 4th, 1935. In life, it was brilliant silvery, with darker brown markings, formed by large densely grouped chromatophores. Eye brown. Peritoneal tubes silvery. Fins white. Base of ventrals black.

New record for Australia.

Family SPARIDAE.

Genus **PARADENTEX** Bleeker, 1872.

Gymnocranius Klunzinger, Verh. K. K. Zool. Bot. Ges. Wien xx, 1870, p. 764. Haplotype, *Dentex rivulatus* Rüppell. Preoccupied by *Gymnocranus* Heine, Journ. für Ornith. viii, 1860, p. 191, a genus of birds.

Paradentex Bleeker, Atlas Ichth. vii, 1872, pl. cccviii, fig. 3. Haplotype, *P. microdon* Bleeker. *Id.* Bleeker, Verh. Akad. Amsterdam xiii, 1873, p. 1. *Id.* Bleeker, Arch. Neerl. Sci. Nat. xi, 1876, pt. i, p. 278—*fide* Weber & Beaufort, Fish. Indo-Austr. Archip. i, 1911, p. 289.

Gymnocranius Bleeker, Verh. Akad. Amsterdam xiii, 1873, p. 41. *Id.* Bleeker, Atlas. Ichth. viii, 1877, p. 95. *Id.* Ogilby, Mem. Qld. Mus. v, 1916, p. 170. *Id.* Fowler, Bull. U. S. Nat. Mus. 100, xii, 1933, p. 129.

Gymnocranius is preoccupied and may require a new name if regarded as distinct from *Paradentex*, but I am not disposed to accord them even subgeneric rank at present. Both forms are represented in Australia and may be distinguished by the presence or absence of wavy blue lines on the sides of the face. A remarkable specimen, apparently aberrant, with a peculiar maxillary outgrowth is described hereunder as a variety. Key to the Australian kinds :—

A. A series of blue wavy bands on the cheeks ("*Gymnocranius*").
  B. Maxillary smooth, largely slipping under pre-orbital. Anal spines gradually increasing in length backwards .. .. *marshalli.*

AA. Cheeks without any wavy bands (*Paradentex*).
  C. Maxillary smooth, slipping under pre-orbital. Anal spines gradually increasing in length backwards .. .. *bitorquatus.*
  CC. Maxillary with a bunch of bony prickles above. Second anal spine thickened, only half the length of the third .. .. *bitorquatus*, var.

There are also minor differences in the number of scales over the lateral line, nuchal scales, proportions of head and depth into length, even curve or gibbosity of profile, and coloration between these and the extra-Australian species of *Paradentex.*

PARADENTEX MARSHALLI, sp. nov.

Dentex rivulatus Rüppell, Neue Wirbelth. Abyssin. (12), 1838, p. 116, pl. xxix, fig. 2. Djedda, Red Sea. Name preoccupied by *Dentex rivulatus* Bennett, Proc. Zool. Soc. Lond. iii (30), Sept. 1835, p. 91, from Trebizond.

Gymnocranius rivulatus Klunzinger, Verh. K. K. Zool. Bot. Ges. Wien xx, 1870, p. 765 and Fische Rothen Meeres, 1884, p. 36 (Red Sea).

? Dentex robinsoni Gilchrist & Thompson, Ann. S. Afr. Mus. vi, 1908, p. 226. Natal, S. Africa. *Id.* Barnard, Ann. S. Afr. Mus. xxi, 2, 1927, p. 712. Said to be a synonym of Rüppell's species, but original description differs in L. lat., coloration, size, etc. and is even more unlike the Australian specimen described hereunder.

Gymnocranius robinsoni Fowler, Bull. U.S. Nat. Mus. 100, xii, 1933, p. 133 (references and synonymy).

Br. 5. D. x/10 (11) ; A. iii/11 ; P. ii/12 ; V. i/5 ; C. 15. L. lat. 50. L. tr. 7/1/17. Five gill-rakers on lower half of first gill-arch.

Head (6 in.) $3\frac{1}{3}$, depth of body ($7\frac{1}{4}$) less than 3 in length without caudal (1 ft. 8 inches). Eye ($1\frac{3}{8}$) 4·3, interorbital ($2\frac{1}{4}$) 2·6, preorbital ($2\frac{1}{8}$) 2·8 in head. Pectoral $4\frac{3}{8}$ in. Length 2 ft. overall.

Maxillary largely sheathed under preorbital, supplementary bone not apparent. Lips fleshy, fimbriate. Peglike teeth in a single series in each jaw but there are also patches of coarse villiform teeth behind each side of the symphyses. Palate

toothless. Preoperculum not notched ; opercles entire. Four rows of cheek-scales ; two or three rows of nuchal scales. No scaly sheaths to fins ; vertical fins pointed. Second anal spine much shorter than third (about $\frac{1}{2}$ of it). Ventrals reaching beyond vent.

General colour (in formalin) pearly grey and silvery. Cheeks and snout crossed by about ten wavy bluish bands. When the fish was fresh, Mr. T. C. Marshall noted the colours as : " General colour silvery with purplish reflections ; numerous narrow wavy blue lines before and below eye. All fins hyaline with traces of pale green. Edges of dorsal and caudal and also anal, orange. Inside of mouth pale orange. These colour notes were made on arrival of the specimen in Brisbane from Townsville when the fish had been on ice about three or four days."

Described from the holotype of the species, upon which the specific name *marshalli* is based, in honour of Mr. T. C. Marshall of the Queensland Museum, who had determined the specimen as a new species of *Gymnocranius*. It is two feet in total length and was obtained by Mr. George Coates from Rib Reef, near Townsville, north Queensland. Registered no. in the Queensland Museum, I. 5284.

This species is not unlike Rüppell's *Dentex rivulatus*, but as that name is preoccupied, and the Red Sea species even differs from the African *P. robinsoni* as described by Gilchrist & Thompson, the Australian form at least requires a new name.

PARADENTEX BITORQUATUS (Cockerell).

Gymnocranius bitorquatus Cockerell, Mem. Qld. Mus. v, July 10, 1916, p. 56. *Ex* Ogilby MS. Moreton Bay, Queensland (scales).

Gymnocranius audleyi Ogilby, Mem. Qld. Mus. v, July 10, 1916, p. 170, pl. xxii. Snapper banks off Moreton Bay, Queensland.

The double naming of this species was overlooked by Ogilby because he was unfortunately ill when volume v of these Memoirs was being printed.

The Australian Museum has Queensland specimens (Nos. I. 11133, 11134, 14037, IA. 3096, 6158, and 6583) from Bustard Bay ("Endeavour "), Great Barrier Reef (Lockwood), and Lindeman Island (M. Ward ; G. P. Whitley).

PARADENTEX BITORQUATUS, var.

(Text-figure 1.)

A remarkable form in the Queensland Museum is evidently referable to this species ; it has, however, bony features about the upper jaws and anal spines which may be due to senility. I have inspected the specimen, which was brought before my notice several years ago by Mr. T. C. Marshall who has furnished the following particulars :—

" D. x/10, 1 ; A. iii/10, 1 ; P. i, 13 ; scales 44 on lateral line to caudal base and 2 more on latter ; 5 above, 17 below ; a lanceolate scale placed above the base

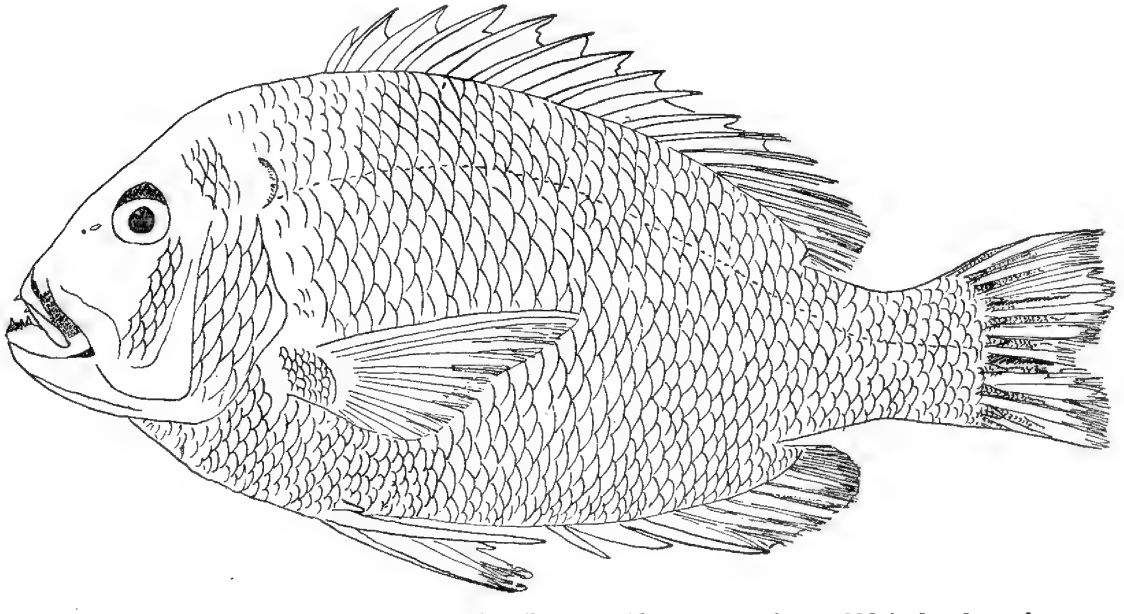
of the ventral spine. . . Tail with small scales almost over its entire length. Crown of the head and interorbital region naked. Operculum and preoperculum scaly. A rough bony rasp on the maxillary, measuring approximately 37 mm. in length.

" No teeth on vomer or palatines. Villiform teeth in a band on upper and lower jaws, with an outer row of anterior canines (6 above and 4 below). There is also an inner row of much shorter posterior canines on the bottom jaw.

" Dorsal, ventral and anal spines very stout and strong, the second anal spine being the stoutest (9 mm. for half its length).

" Colour silvery. Very similar in appearance to the common *Sparus australis*, except that it lacked the golden bands sometimes found in that species. The webs of the spinous and soft dorsal were suffused with bright yellow. Length $23\frac{1}{4}$ inches. Weight $9\frac{1}{2}$ lb."

Locality.—Forty-five miles north-east of Double Island Point, South Queensland; caught by Mr. S. Williams early in 1933. Queensland Museum registered no. I. 5011.



Text-fig. 1.—*Paradentex bitorquatus* (Cockerell) var. Aberrant specimen, $23\frac{1}{4}$ inches long, from 45 miles N.E. of Double Island Point, Queensland. Qld. Mus. regd. no. I 5011.

T. C. Marshall del.

Family SARDIDAE.

Genus **THUNNUS**, South, 1845.[1]

Thynnus, Cuvier, Règne, Animal, ed. 1, " 1817 " = Dec. 1816, p. 313. Tautotype, *Scomber thynnus* Linné. Preoccupied by *Thynnus* Fabricius, Syst. Ent. 1775, p. 360, gen. 113, a genus of wasps.

Thunnus South, Encycl. Metropolitana xxv. 1845, p. 620. Substitute name for *Thynnus* Cuvier preoccupied. Genotype, *Scomber thynnus* Linné. [" *Thunnus* " Oken (Allgem. Naturg. x, 6, 1836, p. 193) and " *Thinnus* " Agassiz (Nomencl. Zool. 1846, Index Univ. p. 369) are not valid generic names, being merely cited ex pre-Linnean authors.]

Albacora Jordan, Proc. Acad. Nat. Sci. Philad. 1888, p. 180. Substitute name for *Thynnus* Cuvier, preoccupied. Orthotype *Scomber thynnus* Linné. *Id.* Whitley, Rec. Austr. Mus. xix, 1933, p. 81.

THUNNUS NICOLSONI, sp. nov.

(Text-figure 2.)

Br. 7. D. xiii/14 + 9 ; A. 13 + 9 ; P. 36 ; V. i/5 ; C. 22.

Head ($7\frac{1}{2}$ inches) 3·7, depth of body (about 6) 4·7, distance from snout to dorsal origin (8) 3·5, from ventral to anal origin (8) 3·5, in length to end of middle caudal rays (28). Eye (1) 7·5, interorbital ($2\frac{1}{2}$) 3, postorbital ($4\frac{1}{4}$) 1·8, maxillary ($2\frac{3}{4}$) 2·7, pectoral (6) 1·2, height of anal (4) 1·9, longest (1st and 2nd) dorsal spines ($3\frac{1}{4}$) 2·5, length of caudal keel ($3\frac{1}{4}$) 2·5, ventrals (3) 2·5 in head. Tips of caudal fin 9 inches apart.

The general habit of head, body, and fins as in tunnies generally. Eye large. Small compressed conic teeth in a single series in jaws. A slender strip of villiform teeth on each palatine and a pear-shaped patch on the vomer. Branchiostegal

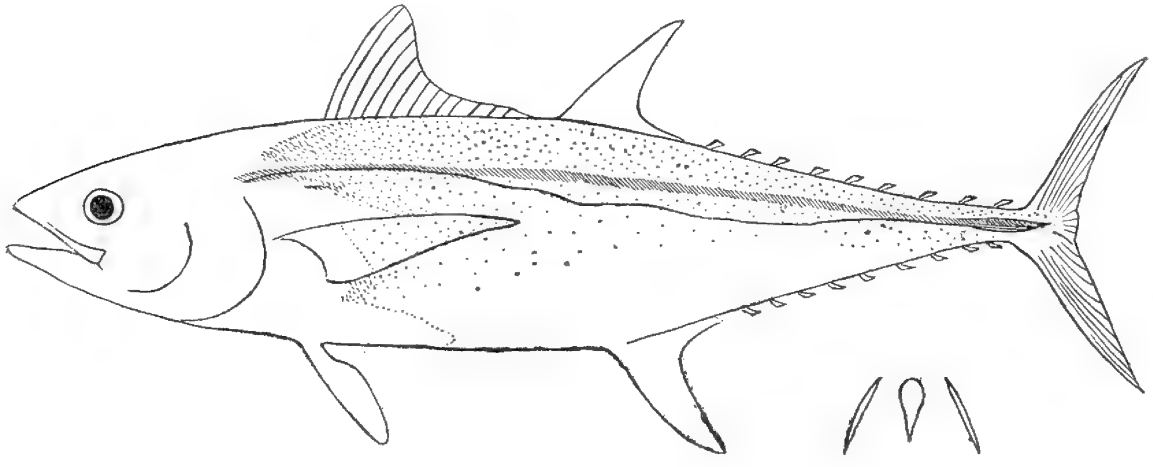
[1] Sherborn, when compiling his " Index Animalium," was unable to find the name *Thunnus* in the Encyclopaedia Metropolitana, volume v, the reference usually cited for it. I too searched in the Mitchell Library, Sydney, without finding where South proposed the name *Thunnus*. I had come to the conclusion that, as *Thynnus* and *Thunnus* were practically interchangeable, and as both words were used by classical authors (Aldrovandi, for instance), the reference to South was mythical, and so, in 1933, I employed the name *Albacora* Jordan for the tunny. Mr. Ludwig Glauert, of the Museum at Perth, Western Australia, then kindly wrote regarding the Encyclopaedia Metropolitana (*in lit*, 28 April, 1934) :—" As we have a copy of this work in our Library, I thought I would investigate the matter for myself. I turned up the general index and found a reference to *Thunnus* in volume 25, where on page 620 South writes :—' Cuvier has applied the word *Thynnus* generically to these fish, but as it had been long before used by Fabricius as the title of a genus of hymenopterous insects, it will be better to use the corresponding word *Thunnus* to prevent confusion.' I think this is the reference for which you and Sherborn have been seeking, and so I am writing to direct your attention to it." Again referring to the Mitchell Library set, I found that Mr. Glauert had indeed tracked down South's name, which occurred in the Encyclopaedia Metropolitana (edition of Smedley, Rose and Rose), vol. xxv, (Miscellaneous and Lexicographical, vol. 12), London, 1845, Zoology by J. F. South, Esq., F.Z.S., Surgeon to St. Thomas' Hospital. The species of *Thunnus* mentioned by South were all taken from Cuvier : *vulgaris*, *brachypterus*, *coretta*, *thunnina*, *brasiliensis*, *brevipennis*, *pelamys*, *alalonga*, *pacificus* (*germon*), *argentivittatus*, and *balteatus*. My thanks are due to Mr. Glauert for tracing this obscure reference. In this connection, I note that Gill (Proc. U.S. Nat. Mus. xvi, 1893 (1894), p. 693) has independently arrived at the same conclusions regarding *Thunnus*.

membrane produced into a backwardly directed point. Seven branchiostegal rays. Pseudobranchiae present. Gill-rakers long and depressed, 6 + 16 on first branchial arch.

Body fusiform, streamlined. It is largely scaly but the corselet area is obscure and naked, and the breast is naked to well behind the paired fins. There are some large scales near the shoulder region. A well marked caudal keel present.

The stomach contained the " pen " of a squid (*Sepioteuthis*), also the remains of some very small fish. Gonads 6″ long.

Peritoneum greyish or pinkish. A second specimen, caught a few days later, had D. xiii/13 + 2 + 8 ; A. 13 + 8.



Text-fig. 2.—*Thunnus nicolsoni* Whitley. Holotype, 30 inches long, and palatal dentition of same, from Lindeman Island, Queensland. Austr. Mus. regd. no. IA. 6553.
Gilbert Whitley del.

Colours when fresh : Dark iridescent blue to dull grey on the back, pearly silvery on flanks, and silvery greyish or white, with greenish reflections, towards belly. A distinct narrow violet band runs directly from the shoulder to above the caudal keel, passing dorsally of the lateral line. Iris pearly ; pupil of eye black. Fins mostly smoky and greyish. Inside of pectoral much darker than outer surface, which is more silvery. Tinges of yellow on dorsal and anal lobes and on membranes of ventrals. Dorsal and anal finlets mostly yellow with whitish margins and grey inframarginal bands.

Described and figured from the holotype of the species, a specimen 30 inches in total length and 12 lb. in weight, caught by Mrs. Norman Strelitz on a white feather lure in two fathoms depth, between Lindeman and Maher Islands, Cumberland Group, North Queensland. Head preserved in formalin ; Austr. Mus. regd. no. IA. 6553. Aboriginal name : Geegorry, pronounced with the g's hard.

I have much pleasure in naming this fine new Tunny after Captain Angus de Salis Nicolson of Lindeman Island in appreciation of his interest and help extended to me during my stay on the island.

Genus **CYBIUM** Cuvier, 1829.

Cybium Cuvier, Règne Animal ed. 2, ii, April 1829, p. 199. Logotype, *C. commersonii* Cuvier = *Scomber commerson* Lacépède, selected by Gill, Proc. Acad. Nat. Sci. Philad. xiv, 1862 (1863), p. 126. *Id.* Cuvier and Valenciennes, Hist. Nat. Poiss, viii, 1832, p. 164. *Id.* Voigt, Das Thierreich (Cuvier) ii, 1832, p. 281. *Id.* Griffith, Anim. Kingdom (Cuvier) x, 1834, p. 185. *Id.* Swainson, Nat. Hist. Fish. Amphib. Rept. ii, July 1839, pp. 174 and 238. *Id.* Bleeker, Nat. Geneesk. Arch. Ned. Ind. i, 1844, p. 553—*fide* Weber and Beaufort. *Id.* Gunther, Cat. Fish. Brit. Mus. ii, 1860, p. 369. *Id.* Baudement, Dict. Univ. Hist. Nat (d'Orbigny), xii, 1861, p. 363. *Id.* Macleay, Proc. Linn. Soc. N. S. Wales, viii, 1883, p. 205 and ix, 1884, p. 28. *Id.* De Vis, Proc. Linn. Soc. N. S. Wales ix, 1884, p. 545. *Id.* Kishinouye, Journ. Coll. Agric. Imp. Univ. Tokyo, viii, 1923, p. 415. *Id.* Jordan and Hubbs, Mem. Carneg. Mus. x, 2, 1925, p. 213. *Id.* Delsman, Treubia xiii, 1931, p. 401 (eggs and larvae).

Cibium Troschel, Arch. f. Naturg. (Wiegmann), xv, i, 1849, p. 380 (gill-rakers).

Scomberomorus of Australian authors, non Lacépède.

I follow Jordan and Hubbs (1925) in reinstating *Cybium* as distinct from *Scomberomorus*. The genus *Scomberomorus* Lacépède (Hist. Nat. Poiss. iii, 1802, p. 292) has as its genotype *S. plumierii* Lacépède from Martinique, a synonym of *Scomber regalis* Bloch (Nat. ausl. Fische vii, 1793, p. 38, pl. cccxxxiii) from the Antilles. Absolute synonyms of *Scomberomorus* are *Polipturus* Rafinesque 1815, *Polypturus* Agassiz, 1845, and *Polypterurus* Agassiz, 1846. The typical American form was not very satisfactorily described by the early authors, but Fowler more recently gives the number of gill-rakers as 8-12 : dorsal spines as 17-18 and 30-40 teeth in each jaw.

Apart from these features, the American species has very different colours from the Australian ones usually called *Scomberomorus* and that name might well be dropped from our lists.

Cybium Cuvier was proposed for a number of species, the first of which, *Cybium commersonii* Cuvier = *Scomber commerson* Lacépède (Hist. Nat. Poiss, ii, 1800, pp. 598 and 600, pl. xx, fig. 1) evidently from Mauritius, was selected as the genotype by Gill.

CYBIUM COMMERSON (Lacépède).

EXTRALIMITAL REFERENCES.

Scomber commerson Lacépède, Hist. Nat. Poiss. ii, 1800, pp. 598 and 600, pl. xx, fig. 1. Based on a drawing by Commerson. No locality, but Cuvier & Valenciennes designate Mauritius. *Id.* Cuvier, Règne Anim. ed. 1, ii, " 1817 " = Dec. 1816, p. 314, footnote.

Scomber commersoni Bloch & Schneider, Syst. Ichth. 1801, p. 545. *Ex* Lacépède. *Id.* Shaw, Gen. Zool. iv, 2, 1803, p. 589, pl. lxxxv, after Lacépède (" Pacific Ocean ").

Scomber maculosus Shaw, Gen. Zool. iv, 2, 1803, p. 592. Based on the " Konam " of Russell, Fish. Vizag. ii, 1803, p. 27, pl. cxxxv. Vizagapatam, India. *Id.* Shaw & Nodder, Nat. Miscell. xxiii, 1811, pl. 982.

Cybium commersonii Cuvier, Règne Anim. ed. 2, ii, April 1829, p. 200. *Ex* Lacépède and Russell. *Id.* Rüppell, Atlas Reise Rüpp., Fische, 1831, p. 94, pl. xxv, fig. 1 (Massowah, Red Sea). *Id.* Cuvier & Valenciennes, Hist. Nat. Poiss. viii, " 1831 " = Jan. 1832, p. 165 (Mauritius & India). *Id.* Rüppell, Neue Wirbelth. Abyssin. Fische, 1836, p. 41. *Id.* Bleeker, Nat. Geneesk. Arch. Ned. Ind. ii, 1845, p. 516 and later papers—*fide* Weber & Beaufort, Fish. Indo-Austr. Arch. i, 1911, p. 149. *Id.* Richardson, Rept. 15th. meet. Brit. Assn. Adv. Sci., 1845 (1846), p. 268 (China). *Id.* Cantor, Journ. Asiatic Soc. Bengal xviii, 2, 1850, p. 1090 ; Cat. Malay. Fish., 1850, p. 108 (Malaya). *Id.* Jerdon, Madras Journ. Lit. Sci., 1851, p. 136—*fide* Day, 1876. *Id.* Gunther, Cat. Fish. Brit. Mus. ii, 1860, p. 370 (Cape Seas, etc.). *Id.* Day, Fish. Malabar, 1865, p. 69. *Id.* Playfair, Fish. Zanzibar,

1866, p. 67. *Id.* Klunzinger, Verh. Zool. Bot. Ges. Wien xxi, 1871, p. 444 (Red Sea). *Id.* Day, Fish. India, 1876, p. 255, pl. lvi, fig. 5 (Madras spem. figd.). *Id.* Döderlein, Nat. Sicil. vii, 1872, pp. 105 & 129, fig. (*fide* Zool. Record). *Id.* Macleay, Proc. Linn. Soc. N. S. Wales viii, 1883, p. 266 (Hood Bay, New Guinea). *Id.* Klunzinger, Fische Rothen Meeres, 1884, p. 112. *Id.* Gilchrist, Mar. Invest. S. Afr. i, 1902, p. 128 (S. Africa). *Id.* Gilchrist & Thompson, Ann. S. Afr. Mus. vi, 1909, p. 248 (Natal spem. descr.). *Id.* Weber, Abhandl. Senck. Naturf. Ges. xxxiv, 1911, p. 31 (Aru Iss.). *Id.* Robinson, Mar. Biol. Rept. S. Africa iii, 1916, p. 63. *Id.* Gudger, Bull. Amer. Mus. Nat. Hist. lviii, 9, 1929, p. 517, nos. 173-174. *Ex* Pike MS. (Mauritius). *Id.* Delsman, Treubia xiii, 1931, p. 401 (Java Sea—eggs & larvae).

? Cybium clupeoideum Cuvier & Valenciennes, Hist. Nat. Poiss. viii, " 1831 " = Jan. 1832, p. 178. Norfolk Island.

? Scomber clupeoides Cuvier & Valenciennes, Hist. Nat. Poiss. viii, " 1831 " = Jan. 1832, p. 178. *Ex* Broussonet MS. Norfolk Island.

Cybium konam Bleeker, Nat. Tijdschr. Ned. Ind. i, 1851, p. 357. Batavia. *Id.* Kner, Voy. Novara, Fische, 1865, p. 144 (Manilla).

Scomber konam Day, Fish. India, 1876, p. 255, in synonymy. Latinization of the vernacular " Konam " of Russell. Vizagapatam.

Scomberomorus commersonii Swain, Proc. Acad. Nat. Sci. Philad. 1882 (1883), p. 306. *Id.* Jordan & Seale, Bull. U. S. Bur. Fish. xxv, 1906, p. 228 (New Guinea) *et ibid* xxvi, 1907, p. 13 (Cavite, Philippines). *Id.* Jordan & Dickerson, Proc. U. S. Nat. Mus. xxxiv, 1908, p. 610 (Suva, Fiji). *Id.* Gilchrist & Thompson, Ann. Durban Mus. i, 4, 1917, p. 395. *Id.* Thompson, Mar. Biol. Rept. S. Afr. iv, 1918, p. 112. *Id.* Barnard, Ann. S. Afr. Mus. xxi, 2, 1927, p. 802.

Cybium multifasciatum Kishinouye, Sui. Gak. Ho, i, 1915, p. 9, pl. i, fig. 3. Japan. *Fide* Kishinouye, 1923.

Cybium commerson Kishinouye, Journ. Coll. Agric. Univ. Tokyo viii, 3, 1923, p. 416, pl. xxii, fig. 36. (Japan). *Id.* Jordan & Hubbs, Mem. Carneg. Mus. x, 2, 1925, p. 214 (few gill-rakers and serrulate teeth).

Scomberomorus (*Cybium*) *commerson* Whitley, Journ. Pan-Pacif. Res. Inst. ii, 1, 1927, p. 5, no. 111 (Fiji).

Scomberomorus commerson Fowler, Proc. Acad. Nat. Sci. Philad. lxxix, 1927 (1928), p. 267 (Philippines). *Id.* Fowler, Mem. Bish. Mus. x, 1928, p. 132 (Oceania). *Id.* Fowler, Proc. Acad. Nat. Sci. Philad. lxxxvii, 1935, p. 138, fig. 104 (Siam) *et ibid.*, p. 380 (Natal).

Scomberomorus (*Scomberomorus*) *commersoni* Deraniyagala, Ceylon Journ. Sci., (B) xviii, 1933, p. 40, pl. i, fig. 1 & text-fig. 1 (Ceylon).

AUSTRALIAN REFERENCES.

" *A Fish of the Tunny kind* " Dampier, Voy. New Holland iii, 1703, p. 162, pl. iii, fig. 5. New Holland [Probably Shark's Bay, W. Australia].

Cybium commersonii Castelnau, Proc. Linn. Soc. N. S. Wales iii, 1879, p. 352 (Sydney, N. S. Wales). *Id.* Macleay, Proc. Linn. Soc. N. S. Wales v, 1881, p. 558 (Port Jackson), and Cat. Austr. Fish. i, 1881, p. 193. *Id.* Ogilby, Rept. Comm. Fisher. N. S. Wales 1886 (1887), Append. A, Cat. Fish. N.S.W., 1886, p. 29. *Id.* McCoy, Prodr. Zool. Vict., dec. xvi, 1888, p. 205, pl. cliv Queenscliff, Victoria). *Id.* Lucas, Proc. Roy. Soc. Vict. (2) ii, 1890, p. 26.

Scomberomorus commersonii Waite, Mem. N. S. Wales Nat. Club ii, Nov. 7, 1904, p. 42. *Id.* Stead, Fish. Austr., 1906, pp. 162 & 264, and Ed. Fish. N. S. W., 1908, p. 98, pl. lxvi & cover design. *Id.* Ogilby, Commerc. Fish. Qld. 1915, p. 36. *Id.* McCulloch, Austr. Zool. ii, 3, 1922, p. 105, fig. 292a (after Day); Austr. Zool. Handbook i, 1922, p. 79, fig. 292a. *Id.* McCulloch & Whitley, Mem. Qld. Mus. viii, 1925, p. 142.

Scomberomorus commerson Whitley, Austr. Zool. iv, 4, 1926, p. 206 (North-West Islet, Qld.). *Id.* Paradice, Mem. Qld. Mus. ix, 1927, p. 82 (Pellew Is., N. Australia). *Id.* Whitley & Boardman, Austr. Mus. Mag. iii, 1929, p. 368 (near Low Isles, Qld.). *Id.* Roughley, Mid-Pacific Mag. xxxviii, 1929, p. 518 & fig. *Id.* Yonge, A Year on the Great Barrier Reef, 1930, p. 215. *Id.* Stephenson, Gt. Barr. Reef Exped. Sci. Rept. iii, 1931, p. 77. *Id.* Whitley, Gt. Barr. Reef Exped. Sci. Rept. iv, 1932, p. 289.

I have given above a fairly extensive series of references for future students as it is felt that this Australian Seerfish (known as Kingfish or Banded Tuna in Queensland and as Spanish Mackerel or Leaping Tuna in New South Wales) may be more critically studied at some later date owing to its economic importance. This nomadic surface fish has been recorded from a very wide range and may not belong to one homogeneous species, the breeding habits and migrations, so far as known, suggesting that it may be divisible at least into subspecies and races when series of specimens can be compared. Whilst Australian specimens generally differ markedly from figures of Indian and other extralimital ones, they vary to some extent amongst themselves and it is very difficult to find differences which can be used as criteria. I have made notes from freshly-caught specimens over a number of years and have compared these with published accounts, but am not yet convinced of the distinction of the Australian ones, which may require re-naming when they, and such nominal forms as are synonymised above, are better known. These fishes recall the Sun-fishes of the genus *Ranzania* in their puzzling variation and wide distribution. Whilst they are doubtless migratory, limits to their travel are apparent, and these fine fishes are not, so far as records go, found very far away from the continental land-masses.

Lacépède's original description is rather diffuse, forming part of a general account of the genus *Scomber*, but his specific characters are : The body very elongate ; ten little fins quite distinct from one another, above and below the tail ; the first dorsal fin long and very low ; the second short, emarginate, and almost the same as the anal ; the lateral line destitute of little bucklers (*plaques*). Lacépède's description having been based on a drawing, he only mentions incidentally the large teeth, general shape and proportions, etc. which appear in the figure, and gives 18 rays as the number in the first dorsal and 5 or 6 for each of the paired fins. The colour, he wrote, was like that of a mackerel, silvery, dark on the back, and variegated on the sides by numerous irregular blotches. More detailed descriptions of specimens from Mauritius would be desirable for comparison with our own forms.

I am unable to identify satisfactorily the species called *Cybium clupeoideum* Cuv. & Val., which has remained unrecognised for over a century. Again translating from French into English, I give the original description from the Hist. Nat. Poissons :

" Broussonet's collection has afforded us a *Cybium* from Norfolk Island, to the west [should be east—G. P. W.] of New Holland, which is there labelled *scomber clupeoides*, and which resembles *guttatum* in its compressed teeth and the form thereof, but which has no spots. It might be one of the two *koningsvisch* of Valentyn.[2]

[2] The account of the kingfish in Valentyn's *Amboina* is not detailed enough for specific determination.—G. P. W.

" I find in it fourteen or fifteen teeth on each side above, and twelve or thirteen below. Under the second dorsal, the lateral line descends at an angle of forty-five degrees, and rises again under the first finlet ; it waves a little until near the lateral keel.

" D. 14-2/15-ix ; A. 2/14-ix.

" This fish appears to be of a dark leaden colour on the back ; the flanks and ventral surfaces are silver ; its fins are grey or brown.

" It is only six or seven inches long."

There is no specimen in the Australian Museum from Norfolk Island which can be identified as this species, which may be nearer the Australian *Cybium guttatum* or *C. semifasciatum* than *C. commerson*.

The first published figure identifiable as *Cybium commerson* is that of Dampier ; it represents the Western Australian form of the species and was probably caught in Shark's Bay in the year 1699. Dampier remarks :

" This is a Fish of the Tunny kind, and agrees well enough with the Figure in Tab. 3. of the Appendix to Mr. *Willughby's* History of Fishes under the Name of *Gurabuca* ; it differs something, in the Fins especially, from *Piso's* Figure of the *Guarapucu*."

Mr. L. Glauert recently received a specimen for the Perth Museum, confirming the existence of this species in Western Australia.

The remaining synonyms and identifications quoted in the above synonymy do not call for special mention here, though several of the authors quoted named their specimens with some reservation. Also the late A. R. McCulloch, studying specimens from New South Wales, thought they " may perhaps be new " and made a MS. description of a specimen caught off Port Stephens along with others, in February 1913 by Dr. M. Lidwill :

" D. xv, 3/12, xi ; Anal, damaged, ? 3/14, x. Pectoral 23. Length from tip of snout to end of middle caudal rays 1210 mm. Head from tip of snout to end of bony operculum, 235 mm. Height about 203. Eye 30. Snout from tip to posterior nostril, 90. Bony interorbital space, 71. Second dorsal spine, 52. Depth of caudal peduncle, 42. Pectoral, 155. Ventral, 53.

" Dorsal, pectoral, and ventrals beginning approximately on the same vertical line. Anterior spines of first dorsal highest, decreasing in length backwards. Second dorsal commencing far in front of anal, terminating above middle of that fin ; its posterior rays are connected with the first finlet. Anterior rays damaged. Anal originating below middle of dorsal, much damaged, its posterior rays connected with the first finlet.

" Maxillary reaching a trifle behind the hinder ocular margin. Lateral line nearly straight to end of dorsal, thence curving down to below middle of body, whence it rises to middle of caudal peduncle. Microscopic teeth are present on the vomer, palatines and tongue."

My own field notes, made in Queensland, are as follows :—

Specimen from North-West Islet, Queensland ; December 1925.—As we were passing Tryon Island we drew near the breakers on the end of the North-West Islet reef, about five miles from land. After a slight delay, caused by engine breakdown, we caught a Barred Spanish Mackerel (*Scomberomorus commerson*), Leaping Tuna of the fishermen. It must have weighed 20 lb. at least and leapt well out of water.

Colours from life.—Iridescent steel-blue above, silvery on sides, with many oblique brownish bars which taper ventrally. Fins and finlets dusky ; first dorsal membranes bluish black. Tail silvery green, dark-tipped. Keel on caudal peduncle dark grey. Lateral line yellowish. Iris burnished golden.

D. xvi/ii, 15 ? + 10 ; A. iii/i, 11 ? + 10 finlets.

Anterior dorsal spines longest. A single row of triangular teeth in each jaw. Villiform teeth on vomer and palatines. Maxillary extending backwards to vertical of posterior ocular margin. Mandible slightly projecting. Scales very minute.

Some flesh was put on ice and we had it boiled for lunch next day. It was firm and white, but not tasty, being mealy, dry, and flavourless. It was better when mixed with turtle soup.—G. P. W., Diary, 3/12/25.

Specimens from near Low Isles, Queensland, Sept. 5, 1928.—Some fishermen damaged the propeller of their launch on coral and had to put in here [Low Isles] from Snapper Island. They had 26 kingfish (*Scomberomorus commerson*) which we photographed. These fish were about 9 or 10 lbs. in weight when cleaned and are developing the reproductive organs. The fishermen say they begin to get them here about June or July when they come up from the south. In about another month they will be larger and mature and spawn about November. They are caught here until December, when they go south again. A " lily " or a piece of white or red rag is used as bait and trolled behind a launch. They bite very ferociously and are often caught in numbers. Yet they do not stay in one place and may not be encountered the day after a good catch has been made. All the fish they had had been caught between Snapper Island and here. Seven pence a pound is asked for the cleaned fish.—G. P. W., Diary, 5/9/28.

Specimens from North-West Islet, Queensland ; May 1931.—Several specimens, the largest weighing eighteen pounds.

D. xvi/16 + 10 finlets ;	A. 16 + 10.
xvi/15 + 10	17 + 10
xvi/17 + 9	17 + 9

Head (4½ in. or 105 mm.) 4·5, depth (88 mm.) 5·4 in standard length (19 in. or 475 mm.). Eye (15 mm.) 7 in head. Upper caudal lobe slightly shorter than head. Steel-blue above, silvery on sides and ventral surface. Dorsal, pectorals, and caudal dark grey. The subvertical greyish bars do not extend much below level of mouth.—G. P. W., Diary, 22 May, 1931.

Specimens from Lindeman Island, Queensland, 1935—

(*a*) D. xvi/16-9 ; A. iii, 14-9 ; P. ii/20 ; V. i/5 ; head about 12 in. Depth about 9 in. Total length 4½ ft. Pectoral 8 in. Eye, 1½ in. Weight 45 lbs. Crossbands from level of anterior part of lateral line downwards, but ceasing before ventral surface is reached ; there are over 50 transverse bars but some are bifurcated and others broken up into spots. 28/7/35.

(*b*) D. xvi/16-9 ; A. 16-9. A " School mackerel," two feet long. Spinous dorsal almost uniform dark grey. Body *spotted* posteriorly, but the spots become elongated to form ten subvertical blotches before level of soft dorsal and anal. 7/8/35.

(*c*) D. xv/16-9 ; A. 16-10. Length 2 ft. 2 in. Similar to (*b*) but crossbands even more pronounced. In neither does the maxillary extend behind the eye. 7/8/35.

Another spotted specimen appeared to be different from the above examples and belongs to the *semifasciatum* form, q.v., *infra.*

Owing to their large size, these fishes have to be studied in the field. The Australian Museum has but few specimens. One however, from between Port Glasgow and Suau Island, Papua, was presented by Mr. Melbourne Ward (No. IA. 5679). It has about thirty-five wavy bands extending to near the ventral surface.

Many popular articles on the " Kingfish " and its capture have appeared in local magazines, papers and angling journals, but of these I shall quote only two. The first is an account by Mr. William Dearness of Townsville, Q., which appeared in the " Orcadian " of January 24, 1935, to which my attention was kindly directed by Dr. Charles Anderson, and the second is from the " Daily Telegraph " (Sydney) of November 8, 1935. Mr. Dearness, evidently writing towards the end of 1934, stated : " The King Fish, or Spanish Mackerel, season is about finished. The visiting boats are returning home, two from Brisbane and two from Rockhampton. They have had a good season and are returning with big cheques. This is the first season that any visiting boats have taken part in the fishing. It was in 1911 when it was first started here. A lighthouse-keeper at Cape Cleveland had been doing a bit of fishing, and caught two and sent them into town, and they were put in a fish shop window as a curio. They had doubts about them being edible owing to their lack of scales. However they got over that and now it is a big industry. They come in on the Queensland coast as far north as Cairns and as far south as Mackay. They

are most plentiful from Palm Islands to Cape Upstart. . . . Average weight of fish 40 to 50 lbs. The biggest one caught so far was 94 lbs. . . . They catch from 1,000 lbs. up to one ton at a time, and then come in and dispose of their catch. . . . The fishermen get fourpence a pound. The fish shops here sell at 1s. a lb., and Rockhampton and Brisbane 1s. 4d. a lb. Any fish not disposed of is smoked. . . . The mackerel come in on this coast for about four months and then disappear, and nobody seems to know where they go."

After a general account of the fishing, the " Daily Telegraph " stated: " Record hauls have been secured this season, and within five days from October 27 to November 1 southern boats railed seven tons of fish to southern markets, while five Townsville fishing boats within the same period landed to local cold storage works catches of 800 to 2,000, and of a total weight of 7,300 lb."

It should be possible for hundreds of specimens to be examined where only a few have been inspected before, so that the Australian fish may receive the same necessary scientific study that the tunnies and other large food-fishes are receiving in other parts of the world, and it is hoped that some biologist will perform this work in the near future. Characters which should be noted, as they may prove to be of diagnostic value, are the number of spines, rays, and finlets; the number of teeth and whether they are ever serrulate; the extent of the colour-markings correlated with growth; the proportions of the parts of the head (eye, jaws, snout, etc.); the course of the lateral line; degree of compression and relation of depth to length; and the number of vertebræ. Stomach contents and condition of gonads should, of course, also be noted for each specimen, with full particulars of locality, and time of capture, and observations made as to relative abundance and direction of movements.

CYBIUM GUTTATUM (Bloch and Schneider).

Scomber guttatus Bloch and Schneider, Syst. Ichth. 1801, p. 23, pl. v. Tranquebar, Madras, India. *Id.* Cuvier, Règne Anim. ed. 1. ii, " 1817 " = Dec. 1816, p. 314. footnote.

Scomber leopardus, Shaw, Gen. Zool. iv, 2, 1803, p. 591. Based on " Wingeram " Russell, Fish. Vizag, ii, 1803, p. 26, pl. cxxxiv, Vizagapatam, Madras, India.

Scomber wingeram Schinz, Das Thierreich (Cuvier), ii, 1822, p. 506, footnote. Based on Russell's " Wingeram."

Cybium interruptum Cuvier and Valenciennes, Hist. Nat. Poiss. viii, " 1831 " = Jan. 1832, p. 172. Pondicherry, Madras, India.

Cybium guttatum Cuvier and Valenciennes, Hist. Nat. Poiss. viii, " 1831 " = Jan. 1832, p. 173. (Pondicherry and Malabar). *Id.* Bleeker, Nat. Geneesk. Arch. Ned. Ind. ii, 1845, p. 516 and later papers—*fide* Weber and Beaufort, Fish. Indo-Austr. Archip. i, 1911, p. 149. *Id.* Richardson, Rept. 15th meet. Brit. Assn. Adv. Sci. 1845 (1846) p. 268 (China). *Id.* Cantor, Journ. Asiatic Soc. Bengal xviii, 2, 1850, p. 1093 and Cat. Malay Fish. 1850, p. 111 (Penang to Calcutta). *Id.* Gunther, Cat. Fish. Brit. Mus. ii, 1860, p. 371. *Id.* Kner, Voy. Novara, Fische, 1865, p. 143. *Id.* Day, Fish. India, 1876, p. 255, pls. lv, fig. 1 and lvi, fig. 4 (Canara and Madras). *Id.* Macleay, Proc. Linn. Soc. N. S. Wales v, 1881, p. 559 and Descr. Cat. Austr. Fish i, 1881, p. 194 (Port Jackson, N.S.W.—descr. copied from Gunther). *Id.* Ogilby, Cat. Fish. N. S. W., 1886, p. 30. *Id.* Hutton, Trans. N. Z.

Inst. xxviii, 1896, p. 315 (Chatham Islands—record very doubtful). *Id.* Rendahl, K. Svenska Vet. Akad. Handl. lxi, 9, 1921, p. 16 (Broome, W. Austr.). *Id.* Kishinouye, Journ. Coll. Agric. Univ. Tokyo viii, 3, 1923, p. 419, pl. xxxiv, fig. 61. *Id.* Delsman, Treubia xiii, 1931, p. 402 and figs. (Java Sea ;—eggs and larvae).

Pelamys atripinnis Gunther, Cat. Fish. Brit. Mus. ii, 1860, p. 371. *Ex* Waterhouse MS. India.

Scomberomorus guttatus Swain, Proc. Acad. Nat. Sci. Philad. 1882 (1883), p. 306. *Id.* Fowler, Proc. Acad. Nat. Sci. Philad. 1904 (Jan. 1905), p. 766 (Sumatra). *Id.* Waite, Mem. N. S. Wales Nat. Club ii, 1904, p. 42. *Id.* Jordan and Seale, Proc. Davenport Acad. Sci. x, 1905, p. 6 (Hong Kong). *Id.* Waite Rec. Canterb. Mus. i, 1907, p. 24 (New Zealand). *Id.* Stead, Fish. Austr. 1906, p. 162, and Ed. Fish N. S. Wales 1908, p. 98 (N. S. Wales). *Id.* Ogilby, Commerc. Fish. Qld. 1915, p. 36 (Queensland). *Id.* McCulloch, Austr. Z ool. ii, 3, 1922, p. 105 and Austr. Zool. Handbook i, 1922, p. 79. *Id.* McCulloch and Whitley, Mem. Qld. Mus. viii, 2, 1925, p. 142. *Id.* Phillipps, N. Z. Mar. Dept. Fish. Bull. i, 1927, p. 45.

Scomberomorus (*Sawara*) *guttatus* Deraniyagala, Ceylon Journ. Sci. (B) xviii, 1933, p. 43, fig. 3 (Ceylon).

The typical form of this species from India has been well figured by Bloch and Schneider, Russell, and Day, and the Australian Museum has a small specimen from Madras. Whilst *Cybium guttatum* has been recorded from several Australian States, authors have not supplied descriptions of their specimens. Unfortunately, I have not much material (only two specimens supposed to have come from New South Wales), and most of the spotted *Cybium* examined from Australia have proved to be either young *commerson* or else the form known as *semifasciatum*. Hutton's record of *guttatum* from the Chatham Islands, upon which the inclusion of the species in New Zealand lists is based, is very doubtful. Even Kishinouye's beautiful figure of a Japanese specimen may not be true *guttatum*. Cantor regarded *Cybium kuhlii* Cuvier and Valenciennes as the young of *guttatum* but of this form I have only a few Malayan examples presented by Mr. D. G. Stead, and one specimen from Sind, India, purchased from Dr. Francis Day. It is noteworthy that less has been written about *C. guttatum* than of *commerson*, and the former may have been confused at times with the young of the latter and both need comparison with *C. clupeoideum* Cuvier and Valenciennes.

The Spotted Spanish Mackerel was said to occur in prodigious schools in New South Wales (Stead), but Ogilby stated it was not common in the Brisbane markets and I have seen no Sydney specimens, so that its occurrence may be sporadic.

A sketch and notes in McCulloch's card-index represent a specimen 21½ inches long, purchased at a Brisbane fish shop on 15/7/1918.

Dark steel blue on back becoming lighter laterally, this colour is fairly sharply defined from the silver sides, especially posteriorly. Some large steel grey spots on the sides distributed asymmetrically but confined to the region between the soft dorsal and anal fins. Membrane of first seven dorsal spines blackish, the remainder white but black-tipped. Edges of soft dorsal blackish, the rest silver. Dorsal finlets dark. Caudal and pectoral blackish towards the margin. Eye golden. The remainder

silver." This Queensland fish differed from those figured from India, in having practically no spots anterior to the soft dorsal and anal fins and such spots as were present were not arranged in such regular rows, also the Australian sketch shows 10 dorsal and anal finlets.

An old photograph in the Australian Museum shows a specimen, probably from New South Wales, with large spots along the whole of the sides and ten dorsal and ten anal finlets. It is about fifteen inches in total length and the maxillary does not quite reach the vertical of the hinder orbital margin.

CYBIUM SEMIFASCIATUM Macleay.

(Text-figures 3-4.)

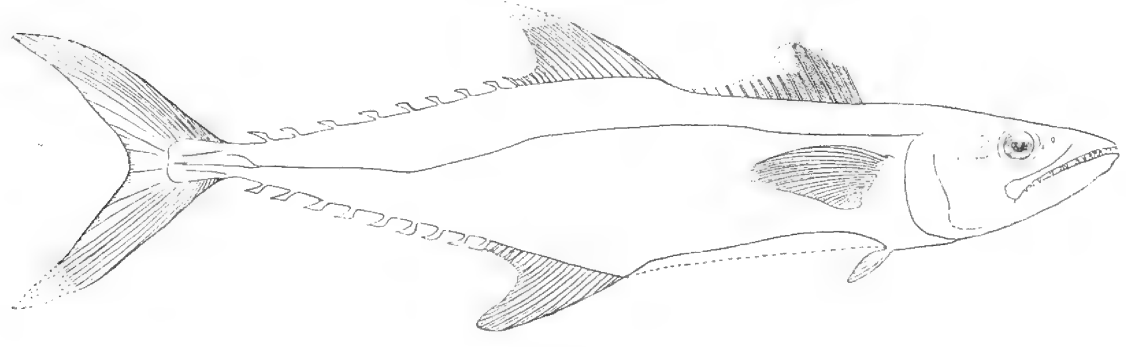
Cybium semifasciatum Macleay, Proc. Linn. Soc. N. S. Wales, viii, July 17, 1883, p. 205 and ix, 1884, p. 28. Lower Burdekin River, Queensland; salt water (coll. A. Morton, 1883). Holotype (No. A. 18288) in Austr. Mus., Sydney.

Cybium tigris De Vis, Proc. Linn. Soc. N. S. Wales, ix, Nov. 29, 1884, p. 545. Cape York, Queensland (coll. K. Broadbent). Holotype (No. I. 119) in Queensland Museum, Brisbane.

Cybium commersoni Saville-Kent, Great Barrier Reef 1893, pp. 291, 311, and 369, pl. xlvi, fig. 1. Probably not *Scomber commerson* Lacépède, 1802.

Scomberomorus tigris, and *semifasciatum* McCulloch and Whitley, Mem. Qld. Mus. viii, 2, 1925, p. 142. *Id.* McCulloch, Austr. Mus. Mem. v, 1929, p. 265 (listed only).

Macleay's type is a very shrunken specimen and is obviously conspecific with *Cybium tigris* De Vis. Figures of both types are given here, the differences between them being due either to variation or shrinking. Macleay's name is the earlier. The Australian Museum also has a specimen collected at Cairncross I., Qld. by Charles Hedley (No. IA. 1598), one obtained by me at Lindeman Island (IA. 6573), and a Cooktown specimen (A. R. McCulloch).

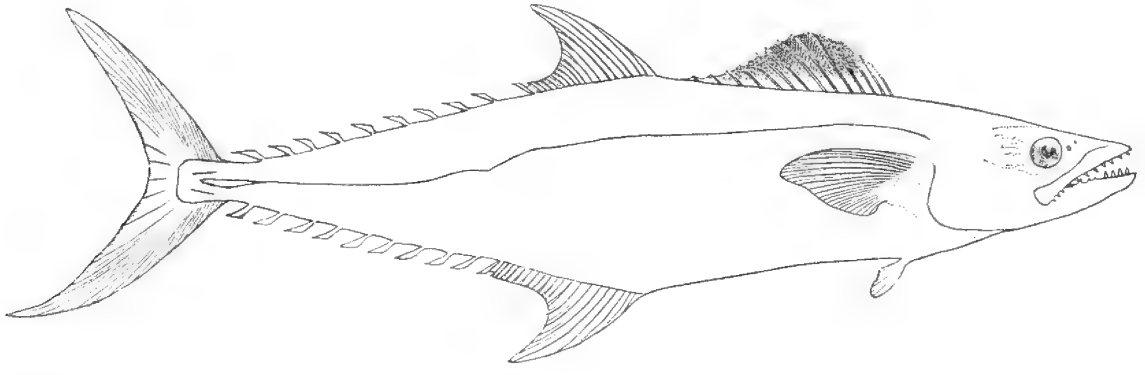


Text-fig. 3.—*Cybium semifasciatum* Macleay. Holotype, about one foot overall, from the Burdekin River, Queensland. Austr. Mus. regd. no. A. 18288. *Gilbert Whitley del.*

De Vis' original description of *Cybium tigris* was brief and his fin-formula inaccurate, so the following details, with a figure, have been drawn up from the holotype.

D. xiv/19 + 9; A. ii/19 + 9; P. ii/21; V. i/5; C. 19 + 5 + 19.

Head (60 mm.) 4·7, depth at origin of soft dorsal and anal fins (62) 4·6 in length to end of middle caudal rays (287). The distance from snout to hypural joint is 273 mm. and the origin of the second dorsal fin is equidistant from these two points. The length of the base of the soft dorsal fin (35 mm.) is equal to the height of its longest (fifth) ray. Anal base (40) a little longer than its height, which is slightly less than that of the dorsal. The last rays of the soft dorsal and anal fins are almost detached as finlets. The dorsal spines are damaged but the fourth (18 mm.) is the longest. Eye (10 mm.) 6, snout (21) 2·8 in head.



Text-fig. 4.—*Cybium semifasciatum* Macleay. Holotype of *Cybium tigris* De Vis, about one foot overall, drawn to same scale as text-figure 3, from Cape York, Queensland. Qld. Mus. regd. no. I 119.

Gilbert Whitley del.

The colours have all faded, but there is some blackish on the membranes of the first dorsal fin. De Vis described the coloration as follows :—" Five distinct cross-bands on the fore part of the back, several others very indistinct on the hinder part. Anterior portion of the spinous dorsal jet black, pectoral dark grey."

Described and figured from the holotype of *Cybium tigris*, a specimen 273 mm. in standard length or about one foot in total length. Queensland Museum registered number I. 119.

Loc.—Cape York, Queensland ; collected by Kendall Broadbent.

Agrees well with the specimen figured as *Cybium commersoni* by Saville-Kent (Great Barrier Reef, 1893, pp. 291, 311, and 369, pl. xlvi, fig. 1), but does not agree in fin-counts or coloration with the larger " *Scomberomorus commerson* " of Australian authors. I have studied numerous specimens of the latter in the field and although it varies in some characters, I have never seen one quite like De Vis' small fish, which is therefore probably not the young of the better known species.

Field notes on Lindeman Id. specimen.—One specimen (Austr. Mus. regd. no. IA. 6573) from between Lindeman and Maher Islands, Cumberland Group ; August 5th 1935.

Colours when fresh.—Upper parts bluish-green, steely and iridescent. Flanks and belly silvery to white with iridescence. Eye pale dirty yellow, pupil black. Mouth and teeth tinged pinkish. Sixteen dorsal spines; the fin mostly blackish except for almost continuous milky blotches over the sixth to last spines and their membranes. Second dorsal and finlets pearly grey with infuscated margins. Caudal similar, also the pectorals, except that the lower rays are white and the inner pectoral surface is darker than the outer. Ventrals, anal fin and finlets white. A few very indistinct bronze spots between the soft dorsal and anal and their finlets. Apparently a not quite mature male. The maxillary does not reach to behind posterior margin of eye. Locally known as School Mackerel and regarded as young *Cybium commerson*. After death the milky blotches on the first dorsal fin became white, also a dull grey stripe appeared, extending from shoulder to upper part of caudal peduncle. No subvertical bars as in *C. commerson* and only diffuse spots on posterior part of body.

D. xvi/17-10; A. ii/17-10. Head 4 inches. Depth of body, $3\frac{1}{2}$. Total length, 1 ft. 10 in. Pectoral $2\frac{1}{4}$ in. and Eye $\frac{5}{8}$ in. Only four gill-rakers. Teeth on vomer and palatines. Anal originating below anterior dorsal rays.

Genus **CYBIOSARDA** Whitley, 1935.

CYBIOSARDA ELEGANS (Whitley).

(Plate IV, fig. 1 and Text-figure 5.)

Scomberomorus (*Cybiosarda*) *elegans*, Whitley, Rec. Austr. Mus. xix, 4, Sept. 19, 1935, p. 236. Off Goat Island, Moreton Bay, Queensland. Type in Queensland Museum. (No. I. 5143). Total length 15 inches.

This beautiful species was recently described from a Moreton Bay specimen caught, with another, by Mr. G. W. Watson, Under Secretary, Chief Secretary's Department, after whom it may appropriately be called Watson's Mackerel. The original description was as follows:—

"D. xvi/16 + 10 finlets: A. 15 + 8 finlets.

"Head (90 mm.) nearly 4, depth of body (75) 4·7 in length to end of middle caudal rays (355). Eye (10) 9, pectoral fin (44) 2·04 in head; interocular space (32) subequal to snout (32).

"Upper profile of head oblique, slightly convex. Posterior nostril a lunate slit. Maxillary reaching to below posterior half of eye and overlying an obilque slit behind the rictus.

"General form mackerel-like, with a high spinous dorsal fin and the body plump. A series of long, spaced, compressed teeth along each jaw. A pear-shaped patch of villiform teeth on the vomer and a spindle-shaped patch on each palatine. Broad areas of lingual teeth. Ten long, slender gill-rakers on lower part of first branchial arch.

" Most of the body surface is naked, but there are small scales along the top of the back and on the caudal peduncle. Others occur along the slightly undulating course of the single lateral line, near the source of which they mingle with larger scales to form a corselet. Caudal peduncle with a keel.

" Dorsal fin highest at about the fifth spine ; the interdorsal space is much less than the diameter of the eye.

" Head dark bluish-grey above and yellow on the sides. Body bluish-grey on the back, brownish on the flanks, and white below. Back with many small spots around spinous dorsal and with large scattered dark grey spots elsewhere ; these become oblique on the sides and transformed into three or four horizontal bands. Spinous dorsal black anteriorly and white at the posterior spines. Other fins and finlets yellow, more or less suffused with dusky infuscations."

As a matter of fact, Watson's Mackerel can now be shown to have a much wider range than was supposed, and I now provide a figure, drawn by Miss Joyce K. Allan, which will render its recognition an easy matter. This species was first caught in numbers off Shellharbour, New South Wales, in 1927, and a photograph of one was published in the " Daily Guardian " (Sydney) May 4, 1927 with the following caption :—

" New Game Fish : Mr. John W. Hockey caught hundreds of a new species of Spanish Mackerel (one of which is shown in the photograph) off Shellharbour recently. He used a spinner for their capture. The markings of the fish combine those of the spotted Spanish mackerel and the horse mackerel. The flesh is rich and tasty."

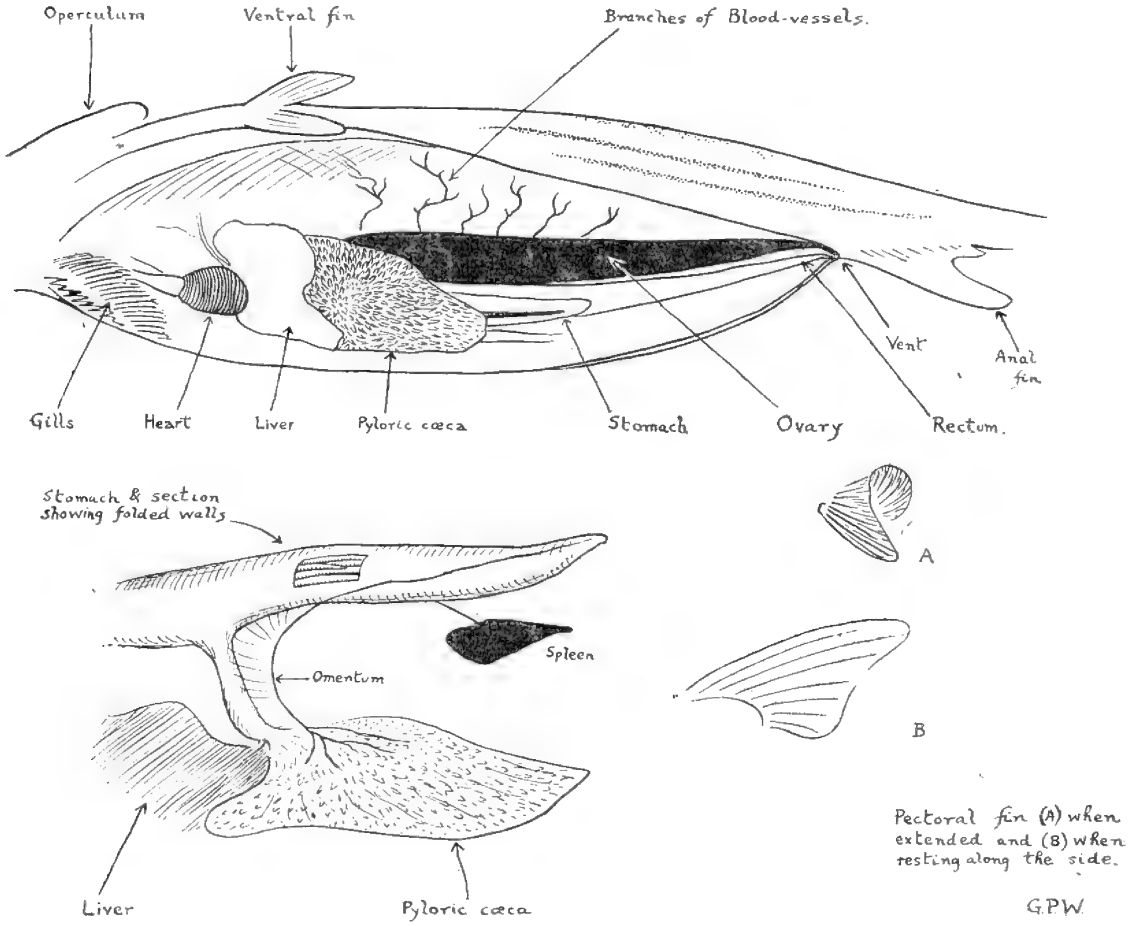
A specimen was secured for the Australian Museum and was sent to the Japanese specialist Dr. Kamakichi Kishinouye who was monographing the Scombroids at that time. He confirmed its novelty and intended to name it in honour of the present writer but his design was cut short when he met his most untimely death at the hands of bandits in China. The specimen, which he himself dissected, was eventually returned and I have it before me now.

It has D. xv/ii, 15 + 9 ; A. iii, 13 + 7 ; vertebrae 45 ; gill-rakers 4 + 9 on first arch, slender and well-developed, not reduced in size and number as in *Cybium*. It is registered No. IA. 3260.

Other specimens had found their way, in March and April 1927, to the Sydney Fish Markets, whence a few were sent to the Australian Museum (Nos. IA. 3470-3473). Then Mr. Watson discovered the species in Queensland, and it was given a new scientific name, his specimens being in the Queensland Museum.

When at Lindeman Island, Cumberland Group, Queensland, in July-September 1935, I secured a few more specimens (Austr. Mus. regd. nos. IA. 6592-6593), one of which is here figured entire. It has Br. 6 ; D. xvi/17 + 9 ; A. 15 + 7,

but does not differ in any marked manner from the more southern ones. The aborigines called these fishes *Gowilla*, or else grouped them with *Cybium commerson* which they called *Woodoona*.



Text-fig. 5.—*Cybiosarda elegans* (Whitley). Dissection of another specimen of about the same size, from Lindeman Island, Queensland; July 23, 1935.
Gilbert Whitley del.

Another specimen caught near Lindeman Island, Queensland, on July 23, 1935, was dissected by me in the field (Text-figure 5) and found to have the following characters :—

Br. 6. D. xvi/17 + 9; A. 15 + 7. Head (82 mm.) nearly 3·8, depth of body (76) 4 in length to end of middle caudal rays (310). Eye (9·5 mm) 8·6, pectoral fin (42) 1·9, interocular space (27) 3, and snout (29·5) nearly 2·8 in head. Agrees generally with the description (then unpublished) of the type of *elegans*. First dorsal spine the longest. Interdorsal space slightly less than diameter of eye. Pseudobranchiae

present. A velum maxillare present in mouth. In this specimen, vomerine teeth are indistinguishable. There is a slight ventral carina. Two reddish gonads, 80 mm. long, and apparently immature roe. Forty-five vertebrae. The anatomical details agree best with those of *Thunnus orientalis* in Kishinouye.

Colours.—Back with mackerel-green iridescence, the spots and stripes greyish. Soft dorsal fin and finlets greyish. Anal lobe yellow, its finlets whitish. Eye dull yellow, the pupil black with a subvertical pearly centre mark. Branchiostegal membrane black, with a white margin.

Finally, Mr. Ludwig Glauert sent me a photograph of a mackerel recently caught at City Beach, Perth, Western Australia, which was immediately recognisable as this same species (W. A. Mus. regd. no. P. 1420).

Thus Watson's Mackerel is evidently a nomadic and gregarious species distributed off the shores of eastern and Western Australia between the latitudes of about 20° and 35° S. It may well prove to be of considerable economic value in the future.

Family POMACENTRIDAE.

Genus **PARMA** Gunther, 1862.

PARMA OLIGOLEPIS Whitley.

Parma oligolepis Whitley, Mem. Qld. Mus. ix, 3, June 29, 1929, p. 230, pl. xxviii, fig. 1. Cape Moreton, Queensland.

Further specimens, besides the types, are in the Queensland Museum from Flat Rock (No. I. 5213) and Mud Island (I. 5249), Moreton Bay, south Queensland.

Family URANOSCOPIDAE.

Genus **ICHTHYSCOPUS** Swainson, 1839.

ICHTHYSCOPUS SANNIO, sp. nov.

Ichthyscopus inermis Waite, Austr. Mus. Mem. iv, 1899, p. 112 (Manning River to Port Kembla, N. S. Wales). *Id.* Borodin, Bull. Vanderbilt Mus. i, 1932, p. 96 (Southport, Queensland).

Not *Uranoscopus inermis* Cuv. & Val., Hist. Nat. Poiss. iii, 1829, p. 310, pl. lxv, from Coromandel and Malabar.

Anema inerme Waite, Mem. Nat. Club N. S. W. ii, 1904, p. 50.

Ichthyscopus lebeck Ogilby, Mem. Qld. Mus. vi, 1918, p. 105 (Tewantin, Q.—size and eggs). *Id.* McCulloch, Austr. Zool. ii, 3, 1922, p. 102 (not fig.); Austr. Zool. Handbook i, 1922, p. 76, and later lists. Not *Uranoscopus Le Beck* Bloch & Schneider, Syst. Ichth. 1801, p. 47, from Tranquebar.

Ichthyscopus lecker Kennedy, N. Qld. Nat. i, 7, 1933, p. 8 (Barron River, Qld.).

The Stargazer recorded from Australia as *Ichthyscopus lebeck* or as its synonym *inermis*, has been identified as such with reservations. As specimens have accumulated, it has become more obvious that our form represents a hitherto unnamed species which differs from figures of the Indian type mainly in coloration, but also in shape and proportions. A Malabar example of the true *I. lebeck*, from Dr. Francis Day's collection, differs from all my Australian ones in having the preocular fringes extending backwards half-way along each side of the interorbital depression,

whereas Australian specimens have the fringes restricted to the anterior part only; they also have the opercles and vertex less granulated than the Indian one, and there are slight variations in fin-rays and teeth.

The Australian Museum has specimens of the new species from numerous localities from Bowen, Queensland, where Mr. E. H. Rainford found it buried in sand at low water, down to Nowra, New South Wales, in which State it is usually trawled in deeper water. From this series, an example just over eleven inches in total length is selected as holotype. It came from Patonga, Broken Bay, New South Wales; Austr. Mus. regd. no. IA. 6309. Ogilby recorded a Moreton Bay specimen over 21 inches long which contained about half a million eggs.

Family BROTULIDAE.

Members of this family are so scarce in Australian waters that it was surprising to find a specimen in the trawl on one occasion in the Cumberland Group. Many genera of this family have been described from other parts of the world, but only a few have hitherto been recorded from Australia. McCulloch's 1929 Check-List[3] gives:— *Brotula ensiformis*, Gunther. *Aphyonus gelatinosus* Gunther. *Dinematichthys iluocoeteoides* Bleeker. *Dinematichthys mizolepis* Gunther. *Dermatopsis macrodon* Ogilby. *Dermatopsis multiradiatus* McCulloch and Waite. *Monothrix polylepis* Ogilby. *Dipulus caecus* Waite. *Typhlonus nasus* Gunther. *Othos cephalotes* Castelnau.

This is a heterogeneous assortment of fishes, not all of them Brotulid, and has to be slightly modified to bring it up to date.

Gill[4] provided the generic name *Nematobrotula* for *Brotula ensiformis*, which thus becomes *Nematobrotula ensiformis*.

I have shown[5] that *Othos cephalotes* is not a Brotulid, but a Serranid fish, *Othos dentex* (Cuv. and Val.), and have published figures of *Dinematichthys mizolepis*[6] and *Dermatopsis macrodon* and *Monothrix polylepis*[7] with a few field notes.

Further, Borodin[8] in 1932 recorded a young *Cataetyx messieri* Gunther from Queensland, and Dr. Borodin assures me (*in lit.* April 14, 1933) that his specimen has the vertical fins confluent with the caudal fin and not separated. However, my Cumberland Group Brotulid is quite different from its Australian allies, being congeneric with a Japanese form, and is accordingly described—

Sub-family SIREMBINAE.

Sirembinae Gill, Proc. Acad. Nat. Sci. Philad. xv., 1863, p. 253.

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[3] McCulloch, Austr. Mus. Mem. v, 1929, p. 355.
[4] Gill, Proc. Acad. Nat. Sci. Philad. xv, 1863, p. 252.
[5] Whitley, Rec. Austr. Mus. xviii, 1932, p. 334.
[6] Whitley, Rec. Austr. Mus. xvi, 1928, p. 303, fig. 2.
[7] Whitley, Rec. Austr. Mus. xix, 1935, p. 239 figs. 8-9.
[8] Borodin, Bull. Vanderbilt. Mus. i, 1932, p. 97.

Genus **SIREMBO** Bleeker, 1858.

Sirembo Bleeker, Act. Soc. Sci. Indo-Néerl. iii, 1858, Ichth. Japan, pp. 3, 22, and 46. Haplotype *Brotula imberbis* Temminck and Schlegel, Fauna Japonica, Pisces 1846, p. 253, pl. cxi, fig. 3, from the Bay of Oomura, Japan.

Brotella, Kaup, Arch. Naturg. (Wiegmann) xxiv, 1, 1858, p. 92. Logotype, *Brotula imberbis* Temminck and Schlegel *loc. cit* (Syn. *Brotella maculata* Kaup), selected by Jordan and Fowler, 1902.

Sirembo Gunther, Cat. Fish. Brit. Mus. iv, 1862, p. 373. *Id.* Bleeker, Verh. Akad. Amsterdam, xviii, 1879, p. 20. *Id.* Jordan and Fowler, Proc. U.S. Nat. Mus. xxv, 1902, p. 756. *Id.* Jordan, Tanaka, & Snyder, Journ. Coll. Sci. Imp. Univ. Tokyo xxxiii, 1913, p. 404.

Kaup's "Uebersicht der Familie Gadidae" in which *Brotella* was proposed and Bleeker's "Vierde bijdrage tot de kennis der ichthyologische Fauna van Japan," wherein *Sirembo* appeared, were published in the same year. Bleeker's paper was signed: "Scripsi Batavia Calendis Ianuarii MDCCCLVII" but was not published until probably after February 1858 and has been given priority over Kaup's paper by subsequent authors.

The Australian Museum has three specimens of *Sirembo imberbis* from Wakanoura, Japan, which confirm my generic identification.

SIREMBO EVERRICULI, sp. nov.

(Plate IV, fig. 2.)

Br. 8. D. circa 84. A.c. 75. P. 21. V. 1. C. 9. Sc. circa 80. L. tr. 8/circa 20.

Head (29 mm.) 5, depth of body (25) 6 in standard length (150). Eye (7) 4·1, interorbital (8) 3·6, preorbital (3) 10, snout (7) 4·1, pectoral (15·5) nearly 2, ventral (20) 1·4, in head.

Head bluntly rounded, the eyes large, with convex interorbital. No barbels. Anterior nostrils in a low tube, posterior ones are large orifices. Most of head covered with thin imbricate scales. A series of mucus pores along edge of preorbital and others on chin. No spine at tip of snout. Operculum with a large spine at its angle and with its inferior margin produced into a few spine-like processes. Mouth large, the truncate end of the maxillary about three-quarters of eye-diameter in measurement.

Bands of fine villiform teeth, the outermost scarcely enlarged, in jaws. Patches of similar teeth on vomer and palatines. No canine teeth. Tongue broadly triangular, adnate to floor of mouth.

Isthmus narrow. Long sparse denticulated gill-rakers on branchiae, eight on lower part of first branchial arch. Gill-openings wide.

Body elongate, tapering, compressed, well invested with oval imbricate cycloid scales, which do not extend over the fins. Many of the scales have the posterior margin notched. The lateral line is even and continuous from the shoulder to between

the posterior dorsal and anal rays and consists of a chain of shallow furrows. Distance from gill-opening to vent rather more than length of head. Anus surrounded by a fimbriated tube, situated a little before the origin of the anal fin.

Dorsal fin originating some distance behind the head; anal fin commencing about two-fifths of the length of the fish from the head. Both dorsal and anal are united to the rather long caudal, which has a rounded margin. About 170 rays in the unpaired fins. Upper pectoral rays longest, but not produced. Ventral fins each consisting of a single filiform ray; they are situated just behind the isthmus, associated with the humeral arch.

General colour in life, silvery, becoming pale olivaceous flushed with pinkish along the back. Ventral surface of head and body white, as are also tip of snout and interior of mouth. Eye silvery, with metallic lustre; pupil blackish. Three longitudinal series of dull golden spots on body, together with some similar smaller spots. Lateral line pinkish-brown. About three golden-brown blotches tend to form an oblique bar passing from snout to operculum through eye.

Dorsal fin dirty whitish, with a kid-white margin and with a row of golden spots, becoming very dark (almost blackish) anteriorly. Anal white, crossed by a dark brown longitudinal band. Caudal white, with one pale golden blotch. Pectorals hyaline. Ventrals white, with a tinge of pink at the base of each ray.

Described and figured from the unique holotype of the species, a specimen 150 mm. in standard length or about $6\frac{1}{2}$ inches overall. Austr. Mus. regd. no. IA. 6564.

Loc.—Off Shaw Island, Cumberland Group, North Queensland. Trawled off "Sea Star Reef" in about 10 fathoms over a mud bottom on a moonlit night, between 9 and 11 p.m., September 13, 1935. Coll. G. P. Whitley. The otter trawl, hauled in by hand by Mr. M. Ward and myself, was unusually heavy to work on this occasion owing to strong currents, nevertheless we obtained 112 specimens of 26 different species of fishes at this time.

Family GOBIIDAE.

AUSTRALAPHIA, gen. nov.

Orthotype, *Australaphia annona*, sp. nov.

Small hyaline perciform fishes with compressed body, cuneiform head, large mouth, and expansive fins. The head criss-crossed by rows of minute mucus-papillae. No scales. Ventral fins approximate. Caudal forked.

Perhaps allied to *Aphia* Risso (Hist. Nat. Europe Merid., iii, 1826, p. 287), but differing in fin-formula and other characters, such as the naked body and forked caudal fin. For observations on the European transparent gobies see Collett (P.Z.S. Lond., 1878, p. 318).

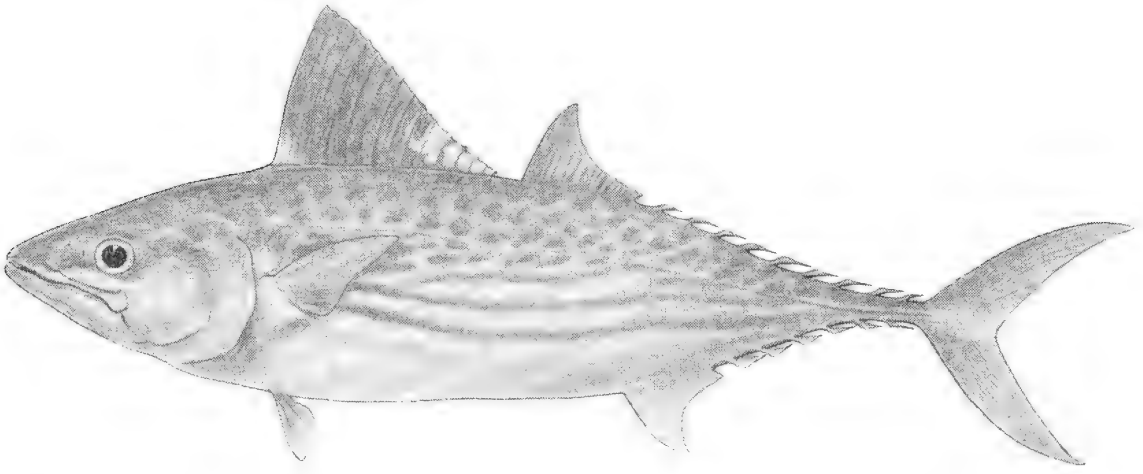


Fig. 1.—*Cybiosarda elegans* (Whitley). A specimen, one foot to end of middle caudal rays, from Lindeman Island, Queensland. Austr. Mus. regd. no. IA. 6593.

Joyce K. Allan del.

Fig. 2.—*Sirembo everriculi* Whitley. Holotype, 150 mm. in standard length, from off Shaw Island, Queensland. Austr. Mus. regd. no. IA 6564.

G. C. Clutton photo.

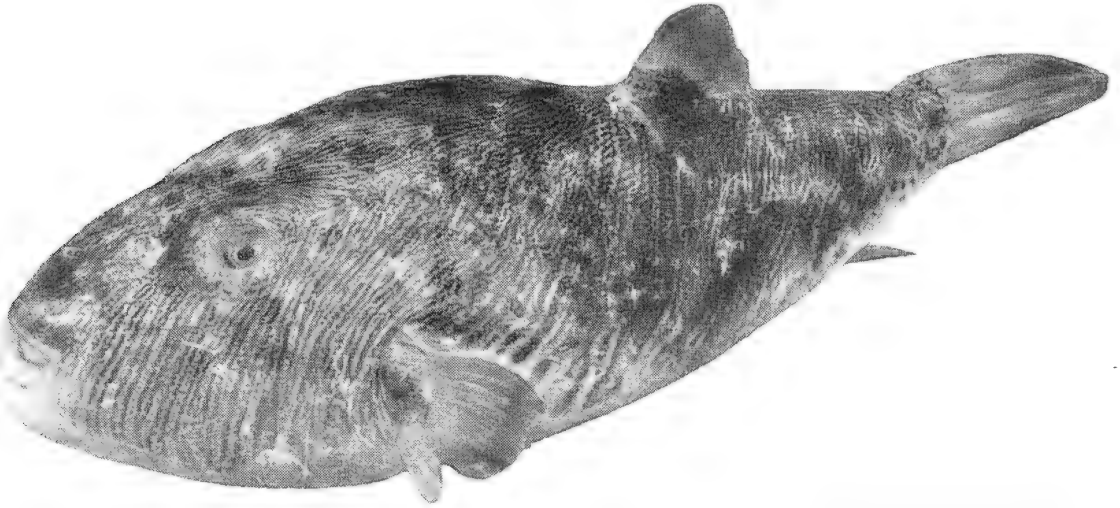


Fig. 3.—*Sphæroides multistriatus* (Richardson). A large specimen from Lindeman Island, Queensland. Austr. Mus. regd. no. IA 6554.

Photo by Professor W. J. Dakin.

Face page 48.

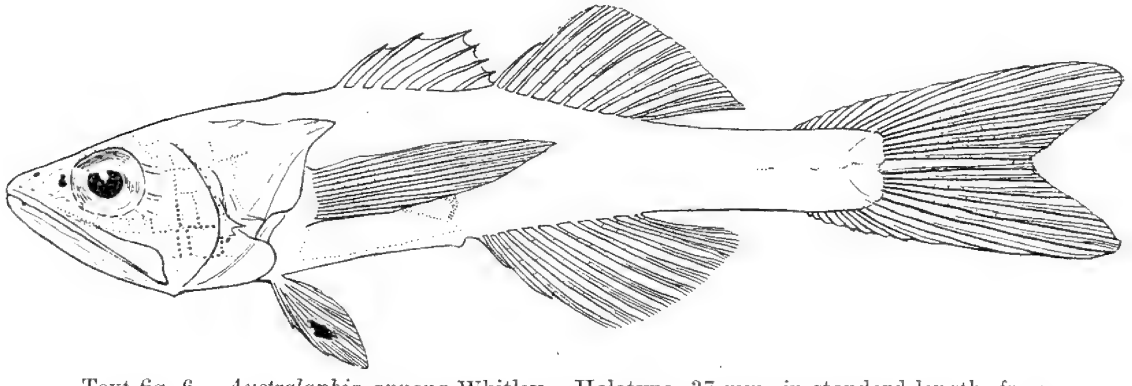
AUSTRALAPHIA ANNONA sp. nov.

(Text-figure 6.)

Br. 6 ? D. vi/11 ; A. ii/10 ; P. 13 ; V. i/5 ; C. 13 main rays.

Head from chin to tip of opercular flap (14 mm.) 2·6, depth (8) 4·6 in standard length (37). Eye (4) 3·5, interorbital (3) 4·7, snout (2·75) about 5, pectoral (10) 1·4, upper caudal lobe (11) 1·2 in head.

Jaws subequal anteriorly, oblique. Maxillary reaching to behind level of eye, its posterior margin excavate, broad, without supplemental bone. Premaxillary broad anteriorly and tapering to a slender bone posteriorly. Premaxillary processes not reaching eye. Acute spaced hooked teeth in a single row in each jaw, largest on sides of mandible. Very fine teeth extend in a single row along the outside of the jaws and along each palatine. Some enlarged teeth on the vomer. Tongue large, acute. Nostrils subcircular. A series of pores around each of the rather large eyes and around the horseshoe-shaped chin. Opercles entire, their bones thin. Integument of head crossed by short vertical and horizontal series of mucus-papillae. A long pointed opercular flap superiorly. Gill-openings wide.



Text-fig. 6.—*Australaphia annona* Whitley. Holotype, 37 mm. in standard length, from indeman Island, Queensland. Austr. Mus. regd. no. IA. 6469.

Gilbert Whitley del.

Body compressed, smooth, naked, almost transparent, the silvery viscera and the bones being distinguishable. An anal papilla present. No apparent lateral line.

Fins all hyaline, the spines weak and the rays branched. Two dorsal fins, approximate. First dorsal originating behind level of ventrals, with six spines, the last somewhat removed from the others. Soft dorsal much higher than spinous dorsal. Anal similar to second dorsal. Caudal broad and fan-like, forked. Pectorals long and pointed. Ventrals approximate but apparently not united by membrane, unless this has been torn ; they do not reach the vent when adpressed.

Colour in alcohol, pale horn-yellowish. The fins hyaline. Eye dark greenish blue.

Described from the unique holotype, a specimen 37 mm. in standard length or nearly $1\frac{5}{8}$ inches overall.

Loc.—Lindeman Island, Whitsunday Passage, Queensland ; April 1935. Collected by Mr. Melbourne Ward. Austr. Mus. regd. no. IA. 6469.

Family ANTENNARIIDAE.

Genus **TATHICARPUS** Ogilby, 1907.

TATHICARPUS MUSCOSUS Ogilby.

? Tathicarpus butleri Ogilby, Proc. Roy. Soc. Qld. xx, Jan. 2, 1907, p. 20. Port Curtis, Queensland. Type in Queensland Museum. (No. I. 861.)

Tathicarpus muscosus Ogilby, Proc. Roy. Soc. Qld. xx, Jan. 2, 1907, p. 20. Port Curtis, Queensland. Type in Queensland Museum.

Tathicarpus appeli Ogilby, Mem. Qld. Mus. vii, 1922, p. 302, pl. xix, fig. 2. Wide Bay, Queensland. Type (I. 3183) in Queensland Museum.

Two specimens, 45 to 70 mm. in standard length, were hand-trawled by Mr. Melbourne Ward and myself in 4 to 8 fathoms between Lindeman and Little Lindeman Is., Cumberland Group, Queensland, in August, 1935. On this rich collecting ground, by using 50 fathoms of warp and shooting the trawl six times, we secured 110 specimens of fishes referable to 26 different species in one afternoon. These angler fishes have the pectoral reaching slightly beyond the anal base and quite a number of cutaneous filaments, suggesting the above synonymy.

Family TETRAODONTIDAE.

Genus **SPHAEROIDES** Anon., 1798, sensu lato.

Sphaeroides Anon., Allg. Lit. Zeit., Sept. 24, 1798, p. 676. Latinization of " Les Sphéroïdes " Lacépède, Hist. Nat. Poiss. ii, 1800, p. 22, Vernac. Haplotype, " Le Sphéroïde tuberculé " of Lacépède = *Orbis tuberculatus* Latreille, Nouv. Dict. Hist. Nat. ed. 1, xxiv, March 1804, p. 75.

Pending a revision of the nominal genera of Tetraodontidae, I use *Sphaeroides* for the following species.

SPHAEROIDES MULTISTRIATUS (Richardson).

(Plate IV, Figure 3.)

Anchisomus multistriatus Richardson, Zool. Voy. Herald, Verteb. 1854, p. 160, pl. xxix, figs. 1-3. *Ex* Kaup Ms. " Southern Polynesia."

Tetrodon multistriatus Gunther, Cat. Fish. Brit. Mus. viii, 1870, p. 285.

Spheroides multistriatus Ogilby, Mem. Qld. Mus. iii, 1915, p. 128. *Id.* Ogilby, *ibid.* vi, 1918, p. 103.

Spheroides multistriatus McCulloch, Austr. Mus. Mem. v, 1929, p. 429.

Originally said to have come from Southern Polynesia, this species finds no place in Fowler's " Fishes of Oceania " or its supplements. May the type have come from one of the early 19th century surveys of tropical Australia ?

Ogilby (1915) gave a good description to supplement the original account of the species.

Ogilby (in MS.) stated that he received a fine specimen of this species from Townsville, north Queensland, in September 1913. Again in June 1917, Ogilby himself secured a beautiful example on the outer Caloundra bank, southern Queensland. In 1914, Ogilby wrote to McCulloch saying " According to Regan, the original specimen is lost. He knows nothing of it except the description and the figure."

One large specimen (Austr. Mus. regd. no. IA. 6554) from Lindeman Island, north Queensland, 15th September, 1935, where Professor W. J. Dakin kindly took photographs of the specimen. Its stomach contained fish vertebrae and pulped remains and the ovaries were fairly well developed.

CYPRICHTHYS, gen. nov.

Orthotype, *Tetraodon mappa* Lesson.

This species is quite unlike an *Anosmius*, as Bleeker contended, and evidently requires generic separation from the other Tetraodontidae.

CYPRICHTHYS MAPPA (Lesson).

Tetraodon mappa Lesson, Voy. Coquille. Zool ii (1), 1831, p. 102, pl. v, " Baie de Doréry à la Nouvelle Guinée " = Port Dorey.

Tetraodon calamaroides Bleeker, Nat. Tijdschr. Ned. Ind. i, 1850, p. 96. Batavia.

Crayracion mappa Bleeker, Atl. Ichth. v, 1865, p. 72, pl. ccx, fig. 3 (refs. and synon.). *Id.* Bleeker, Arch. Neerl. Sci. Nat. xiii, 1878, p. 57 (*fide*. Weber and Beaufort).

Tetrodon mappa, Gunther. Cat. Fish. Brit. Mus. viii, 1870, p. 293 (East Indies and Zanzibar). *Id.* Macleay, Proc. Linn. Soc. N. S. Wales vii, 1883, p. 597 (Port Moresby, New Guinea). *Id.* Gunther, Journ. Mus. Godef. vi, 17, 1910, Fische Sudsee ix, p. 464. *Id.* Fowler, Mem. Bern. P. Bishop Mus. x, 1928, p. 469 and xi, 1934, p. 449 (Polynesian locs.).

One large specimen (Austr. Mus. regd. no. IA. 6555) from Lindeman Island. New record for Australia.

ASTACOPSIS FLECKERI.

By Kathleen Watson, B.A.

Following the recent description, from a single specimen, of *Astacopsis fleckeri*, it was pleasing to receive thirteen additional spiny crayfish in January of this year. These specimens, consisting of twelve females and one male ranging from 121 mm. to 265 mm. in length, were collected by Mr. Pat Flecker in the upper reaches of the Mossman River, north of Cairns, about 4,000 feet above sea level, and were presented to the Museum by the North Queensland Naturalists' Club.

The thirteen specimens show very little variation in specific characters. In all, the carpus of the cheliped is relatively smooth, the exopodite of the 3rd maxilliped is well developed and the antennal scale has the same broad semi-circular shape. In all, too, the rostrum is characteristically rounded and concave, with blunt spines round the margin. The number of these spines, however, varies from 7 to 9, while one specimen has only 5. The number of spines on other parts also varies slightly, especially on the border of the 2nd abdominal segment, but the general arrangement of the sculpturing and armature is similar to that of the type specimen.

ON THE SILURIAN CORALS: *Cyathophyllum shearsbyi and Heliophyllum yassense.*

By O. A. Jones, M.Sc. (Q'land and Cantab.), F.G.S.

(Plates V—VII.)

This revision has been made possible by the work in England of Dr. Stanley Smith, Dr. W. D. Lang, Mr. Ryder, and Mr. Tremberth on the types and species of various coral genera. The examination of the types of European genera is the essential basis on which the very necessary revision of Australian genera and species must rest.

The coral *Cyathophyllum shearsbyi* was described in manuscript by R. Etheridge Junr. 1904 and the name published in a footnote to a paper by him in the same year. Sussmilch published an excellent figure, but no description of the species, in 1914; and Chapman in 1920 gave a brief description and two figures of the coral.

T. A. Ryder in 1926 fully described and figured a generic series of three corals from England, and while there is a striking resemblance of *Cyathophyllum shearsbyi* to one of these, certain important differences of development make it advisable to found a separate genus for the Australian form.

HERCOPHYLLUM* gen. nov.

* τό ἕρκος—a net, referring to the thick net of dissepiments.

Genotype, *Cyathophyllum shearsbyi* Sussmilch, 1914, Fig. 143 facing p. 44, Limestone Creek, Yass, New South Wales, Silurian.

Diagnosis.—Simple, horn shaped or cylindrical, rugose corals which in the mature stage exhibit the characters of the corresponding stage of *Phaulactis* Ryder[1] but which differ from it in the brephic and neanic stages. In the brephic stage of *Hercophyllum* the septa are much dilated and laterally contiguous; in the neanic stage the dilation disappears and a lesser amount of dilation which is confined to the inner ring of dissepiments, the axial ends of the minor septa and the major septa at the same zone appears. In the ephebic stage this secondary thickening is reduced and finally disappears.

Remarks.—Although this genus is identical with *Phaulactis* Ryder in the ephebic stage yet the ontogeny, in my opinion, is sufficiently different from that of *Phaulactis* for it to be separated from the latter. The two genera, *Hercophyllum* and *Phaulactis*, are an excellent example of convergent evolution.

[1] For full details of this genus *see* T. A. Ryder (1926, p. 362 *et seq.*, plates XI, XII) and W. D. Lang and S. Smith (1927, pp. 457-8, 471-2).

The extended diagnosis of this genus as given by Lang and Smith reads:—"Simple subturbinate or cylindrical, straight or curved, Rugose corals, with long septa; no distinct axial structure; small distally arched tabulæ; and fine dissepiments, which may constitute the greater part of the coral tissue. In the earlier formed parts of the corallum the septa are typically much dilated and laterally contiguous; but in the later stages this secondary thickening is restricted to the axial ends of the septa, or is altogether absent."

HERCOPHYLLUM SHEARSBYI (Sussmilch).

(Plate V, Figs. 1a-1g; Plate VI, Fig. 1a-1g.)
(Plate VII, Fig. 1h-1i and Fig. 2.)

Cyathophyllum shearsbyi C. A. Sussmilch (ex R. Etheridge, Junr. M./S.) 1914, Fig. 143 facing p. 44.

Cyathophyllum shearsbii Sussmilch; F. Chapman, 1920, p. 183; pl. 18, Fig. 7; pl. 19, Fig. 9.

N.B.—Etheridge (1904 p. 288 footnote) introduced this name, but did not figure or describe the species. Harper (1909 p. 39 *et seq.*) and Shearsby 1912 p. 113 have both used the name without validating it.

Holotype, the specimen figured by Sussmilch 1914, Fig. 143, facing p. 43. Now in the collection of the Newcastle Technical College. The section cut from it is in the possession of Mr. Sussmilch.

Description.—External characters. The coral is turbinate, at first becoming cylindrical with age, when the diameter may be as much as 5 cms., and the length 12 cms.[2] The calyx has not been observed nor is the basal epitheca preserved on any specimen which the writer has examined.

Internal characters.—The major septa, 50 to 55 in number, are long and slightly flexuous, reaching to or almost to the centre, and in the mature stage are very thin and not dilated except perhaps very slightly at the theca. The minor septa are half to two thirds the length of the major, reaching to the theca where they may be slightly dilated.

The species is markedly bi-areal in character, the theca being formed by the junction of the nearly horizontal tabulae with the numerous small vertical strongly arched dissepiments. The extrathecal area is one half to two thirds of the size of the intrathecal. The tabulae are thin, numerous and incomplete, slightly arched distally. Secondary thickening is absent except perhaps for a slight development affecting part of both cycles of septa at the theca and the inner ring of dissepiments.

Description of the holotype.—The section reveals it to be moderately mature with slight septal dilation at the theca; this is more marked on the cardinal septum side. The septa are very thin in the centre of the corallite.

Ontogeny (*see* plates v to vii).—The ontogeny as determined from serial sections of a considerable number of individuals differs materially from that described for the *Pycnactis—Mesactis—Phaulactis* series (*See* Ryder 1926, p. 393). The ontogeny of Ryder's series may be summarised as follows—slight attenuation of septa from the axis outwards followed by reduction of stereoplasmic thickening and attenuation of septa from the periphery inwards with the appearance of minor septa and dissepiments; the ephebic *Phaulactis* showing but a little secondary thickening on the axial ends of the major septa or none at all.

[2] The writer has seen only one specimen of this size. Most are considerably smaller.

In *Hercophyllum* the earliest stage observed exhibits 23 major septa which are much dilated throughout their length and are embedded in a thick mass of stereoplasm which extends to the centre of the corallite. This stereoplasm is quickly reduced from the axis towards the periphery, and at the same time the septa are somewhat reduced in thickness. At the end of this, the brephic stage, the stereoplasm outside the septa has almost or entirely disappeared but the septa remain much thickened. In the neanic stage the progressive thinning of the septa, continues sometimes to completion, sometimes merging into the secondary thickening at the theca which appears towards the end of this stage. Minor septa and dissepiments are introduced. In the ephebic stage the coral presents the following appearance—an outer ring of numerous thin dissepiments, a zone of thickening at the theca, affecting the major and minor septa and the inner ring of dissepiments. The secondary thickening is progressively reduced and may disappear entirely, when the resemblance to a mature *Phaulactis* is complete.

Summarising the evolution is

1. reduction of secondary thickening from axis toward periphery ;
2. introduction of minor septa and dissepiments with renewed secondary thickening at the theca ;
3. reduction and final disappearance of secondary thickening.

It may be thought that the close resemblance of *Hercophyllum* to *Phaulactis* in the mature stage would justify its inclusion in the latter genus ; but it is increasingly recognised that it is more important to separate lines of evolution than to group together similar products of different lines. It was this consideration that inclined the writer to the view that the form under consideration should be regarded as generically distinct from *Phaulactis* Ryder.

Localities.—Limestone Creek, Yass, N.S.W. (Etheridge) ; Hatton's Corner, Yass, N.S.W. Upper Silurian. Native Dog Creek and Cowombat Creek, Limestone Creek District, Eastern Victoria (Chapman) Yeringian.

A specimen from Wellington, N.S.W. (Silurian) University of Queensland F3173 may be doubtfully referred to this species.

"HELIOPHYLLUM YASSENSE" Eth. fil.

The rugose coral "*Heliophyllum yassense*" was described from Yass by R. Etheridge, Junr. in 1892. The genus *Heliophyllum* was erected by Hall in Dana 1846 (p. 183) as a subgenus of *Cyathophyllum*. The type chosen by Edwards and Haime (1850, p. LXIX) is *H. halli* which equals *Strombodes helianthoides* ? Goldfuss (1826, p. 61, pl. XX, fig. 2) and Phillips (1841, p. 11, pl. V, fig. 13) ; Hall (1843, p. 209, fig. 3 on p. 209). This is not *Cyathophyllum helianthoides* of Goldfuss or of Phillips.

Heliophyllum halli is a Middle Devonian form with carinate septa, and for long after Edwards and Haime there was a tendency to lump together under *Heliophyllum* all cyathophylloid corals with carinae.

A paper by Dr. Stanley Smith and Mr. Tremberth published in 1929 has made it possible to state more clearly and certainly the relationships of " *Heliophyllum yassense.*"

Lang and Smith (1927, p. 461) described the new genus *Xylodes*, and Smith and Tremberth (1929) amplified this and described and figured the species *Xylodes articulatus* (Wahlenberg) and *Xylodes pseudodianthus* (Weissermel).

Under the species *Xylodes articulatus* and *Xylodes pseudodianthus* Smith and Tremberth group corals ranging from those with thin septa and without carinae to those with strongly developed carinae and generally thickened septa, the name *X. pseudodianthus* being confined to the latter, while *X. articulatus* includes forms with some carinae.

The description below shows that the coral *Heliophyllum yassense* Eth. fil. must be referred to the genus *Xylodes* and that its place in the series lies between those two species.

XYLODES Lang and Smith.

The genus *Xylodes* was erected by Land and Smith (1927, pp. 461-462) and a slightly amplified diagnosis was given by Smith and Tremberth (1929, pp. 362-363) ; this diagnosis is as under—

> " Phaceloid, dendroid (or even cerioid) Rugose Corals with marginal parricidal gemmation ; with long typically unmodified septa, of which the major usually reach or nearly reach the axis, with tabulae differentiated into an outer and inner series and with numerous small dissepiments. Carinae may or may not be present, but there is no stereozone."

XYLODES YASSENSE (Eth. fil).

(Plate VII, Figs. 3-5.)

Heliophyllum yassense R. Etheridge, Junr. 1892, Rec. Geol. Surv. N.S.W., Vol. 11, pt. 4, pp. 170-172 ; pl. XI, fig. 8 ; pl. XII, figs. 1-3, Yass. Silurian.

Heliophyllum yassense Eth. fils. ; C. A. Sussmilch, 1914, fig. 13, No. 5 facing p. 42, fig. 14a facing p. 44.

Holotype, Etheridge did not indicate a type specimen, but the specimen figured by Etheridge 1892, pl. 1, fig. 8, is usually regarded as the type. I have not been able to trace any of the specimens figured by Etheridge. In a letter to me the Secretary to the Trustees of the Australian Museum said the type specimen " is probably housed in the Mining Museum, Sydney, but a search made recently has failed to reveal it." If it is definitely established that this specimen is lost it will be necessary to select a neotype.

Etheridge's figure 8, pl. xi, is an external view of a well preserved typical colony of the species.

Description.—Corallites long, slender and cylindrical or squat and turbinate. The cylindical type often united by lateral processes. Major septa long meeting or almost meeting at the axis. Minor septa much shorter than the major. Carinae well developed, originating from a zig-zagging of the septa from which elbows arise. Secondary tissue almost absent. The dissepiments are small and strongly arched, forming a wide extrathecal area. The tabulae area differentiated into two series—a narrow outer series, small and distally concave and a wide inner series made up of distally arched plates irregularly placed and seldom complete.

Remarks.—The above description shows clearly that "*Heliophyllum yassense*" belongs to the genus *Xylodes*, but just where in the *articulatus-pseudodianthus* gradation it should be placed is doubtful. *Xylodes yassense* resembles *Xylodes articulatus* in

(1) the frequent occurrence of cylindrical forms
(2) the absence of secondary thickening.

It resembles *Xylodes pseudodianthus* in

(1) the external character of the turbinate forms.
(2) The character of the inner series of tabulae.

The development of carinae is not quite as pronounced as in *pseudodianthus*.

Etheridge described the species from material about which he said "I am not in a position at present, I regret to say whether the present specimens are from the Devonian or Upper Silurian of the Yass district, but in all probability they are from the latter."

His description of the external form is good and his illustration pl. xi, fig. 8 is excellent and one corallite shows well the marginal parricidal gemmation which is characteristic of *Xylodes*. His description of the transverse section is good, except that he considered that although the septa are very unequally developed, "no determinate subdivision into primary and secondary takes place." Pl. xii, fig. 1 is a good drawing of the transverse section and fig. 2 is an excellent enlargement of a number septa showing the type of carinae. Pl. xii, fig. 3 which he describes as "a partially vertical, partially oblique section" fails completely to reveal the character of the tabulae, and Etheridge did not recognise the two series characteristic of the genus.

Localities.—Hatton's Corner, Yass; Derrengullen Creek, Yass.

Age.—Upper Silurian.

BIBLIOGRAPHY.

Chapman, F., 1920. Palæozoic Fossils of Eastern Victoria, pt. iv, Rec. Geol. Surv. Vic., Vol. iv, pt. 2, pp. 175–194.

Dana, J. D., 1846. Genera of Fossils of the Family Cyathophyllidæ. Amer. Jour. Sci. and Arts (Silliman's Journal), 2nd ser., vol. 1, pp. 178–189.

Edwards, H. M., and Haime, J., 1850–1854. Monograph of British Fossil Corals. Introduction and pt. i 1850, pt. ii 1851, pt. iii 1852, pt. iv 1953, pt. v 1854.

Etheridge, R., Junr., 1892. Descriptions of four Madreporaria Rugosa—species of the Genera *Phillipsastræa*, *Heliophyllum* and *Cyathophyllum*—from the Palæozoic rocks of New South Wales. Rec. Geol. Surv. N.S.W., Vol. ii, pt. 4, pp. 165–174, t. xi and xii.

Etheridge, R., Junr., 1904. Rec. Aust. Mus., Vol. v, pt. 5, p. 288 (footnote).

Goldfuss, G. A., 1826. Petrefacta Germaniæ. Vol. 1, pt. i, pp. 1–76, pls. 1–xxv.

Hall, J., 1843. Natural History of New York pt. iv, Geology of New York pt. iv, comprising the survey of the fourth geological district. pp. xxxiii + 686, 34 + 19 pls., map ; section.

Harper, L. F., 1909. The Geology of the Murrumbidgee River District, near Yass. Rec. Geol. Surv. New South Wales, Vol. ix, pt. 1, pp. 1–54, t. 1–xii, with four maps.

Lang, W. D., & Smith, S, 1927. A Critical Revision of the Rugose Corals Described by W. Lonsdale in Murchison's 'Silurian System.' Quart. Journ. Geol. Soc., Vol. l xxxii, pt. 3, pp. 448–91 & pls. xxxiv–xxxvii.

Phillips, J., 1841. Figures and Descriptions of Palæozoic fossils of Cornwall, Devon and West Somerset. Geol. Surv. Gt. Britain & Ireland, pp. xii + 231, lx, pls. 8vo London.

Ryder, T. A., 1926. *Pycnactis*, *Mesactis*, *Phaulactis* gen. nov. and *Dinophyllum* Lind. Ann. Mag. Nat. Hist., Ser. 9, Vol. xviii, pp. 385–401, pls. ix–xii, Nov. 1926.

Shearsby, A. J., 1912. The Geology of the Yass District. 13th Rep. A.A.A.S. Vol. xiii, pp. 106–119, t. 1–6, and map.

Smith, S., and Tremberth, R., 1929. On the Silurian Corals *Madreporites articulatus*, Wahlenberg and *Madrepora truncata* Linnæus. Ann. Mag. Nat. Hist., Ser. 10, Vol. iii, pp. 361–376, pls. vii & viii.

Sussmilch, C. A., 1914. An Introduction to the Geology of New South Wales. Angus & Robertson Ltd.

EXPLANATION OF PLATES.

PLATE V.

Hercophyllum shearsbyi (Sussmilch).

Figs. 1a–g. Serial sections of a specimen from Hatton's Corner, Yass, N.S.W. × 3. Now in the Queensland Museum. Reg. No. F2479.

PLATE VI.

Hercophyllum shearsbyi (Sussmilch).

Figs. 1a–g. Serial sections of a specimen from Hatton's Corner, Yass, N.S.W. × 1·5. Now in the University of Queensland. Reg. No. F3174, Sections Nos. 809 to 813. No. 1b is at about the same stage of development as Pl. V, No. 1d.

PLATE VII.

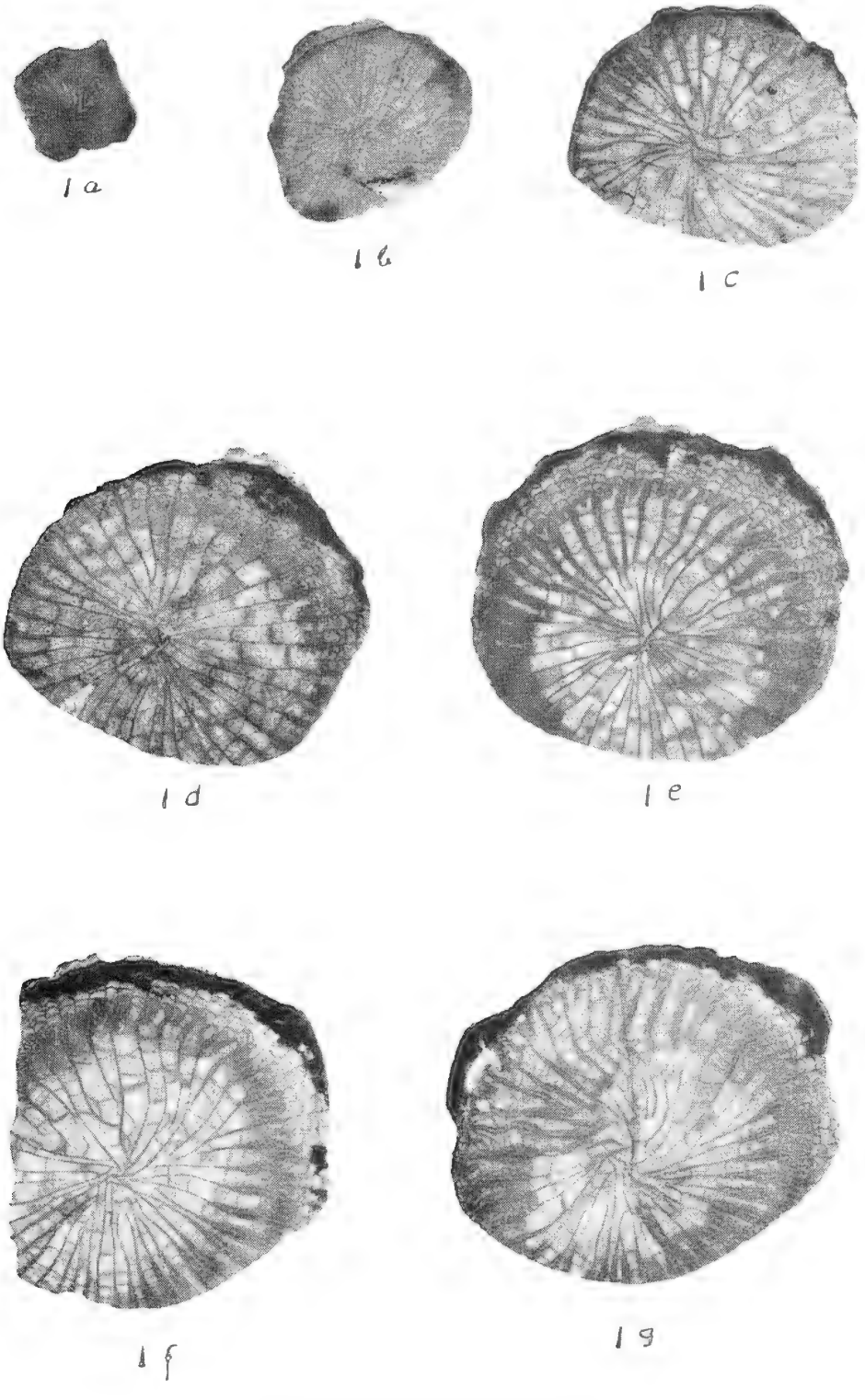
Figs. 1h–i. *Hercophyllum shearsbyi* (Sussmilch). Continuation of serial sections Pl. VI, × 1·5. Section Nos. 813, 814. Fig. 1h is a duplicate of Fig. 1f Plate VI.

Fig. 2. *Hercophyllum shearsbyi* (Sussmilch). Longitudinal section, × 1·5. Section No. 816.

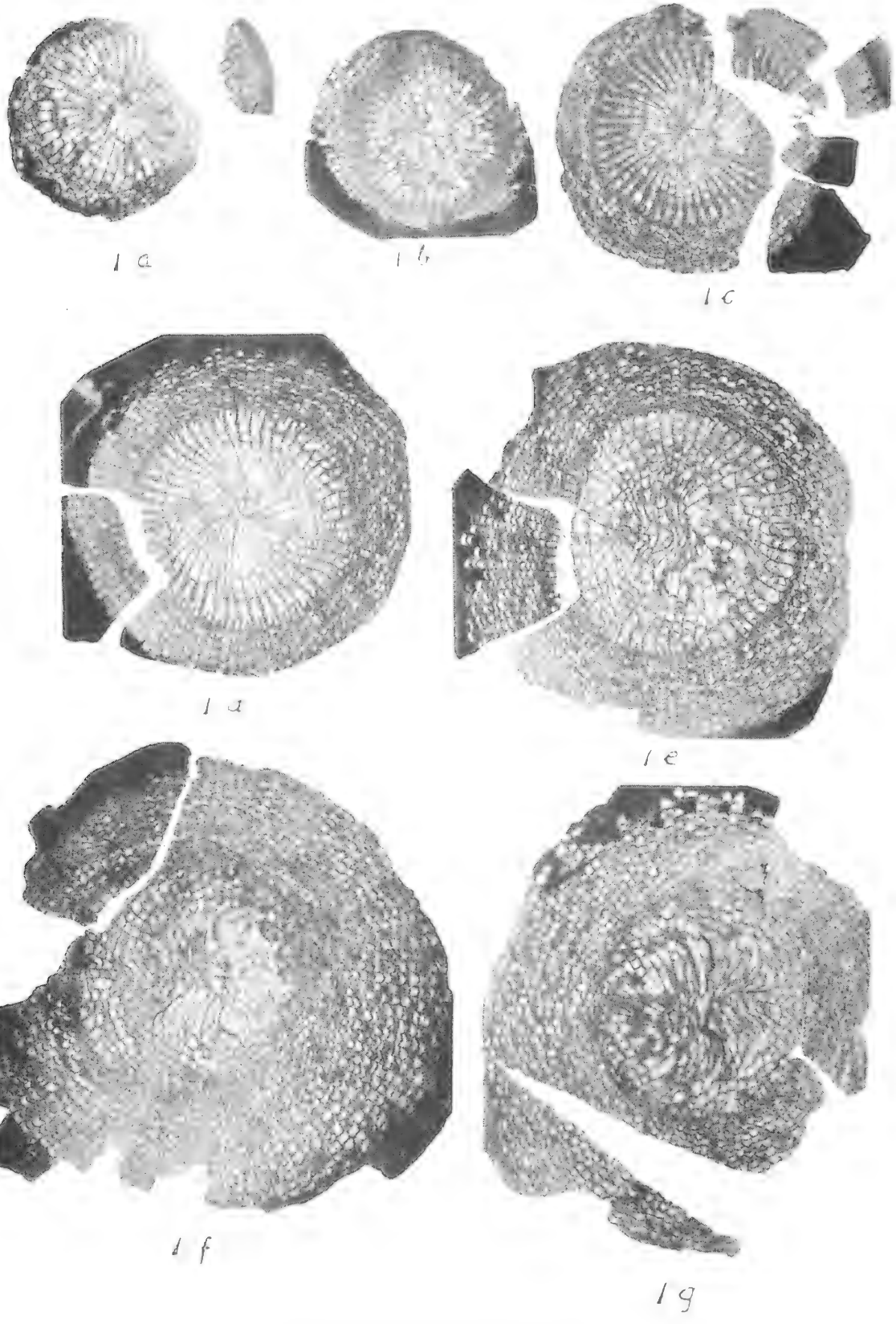
Fig. 3. *Xylodes yassense* (Eth. fil.) specimen from Hatton's Corner, Yass. N.S.W. Transverse section of the turbinate type, × 3. Specimen in the University of Queensland. Reg. No. 1003. Section No. 807.

Fig. 4. *Xylodes yassense* (Eth. fil.) Longitudinal section, × 2. Section No. 804.

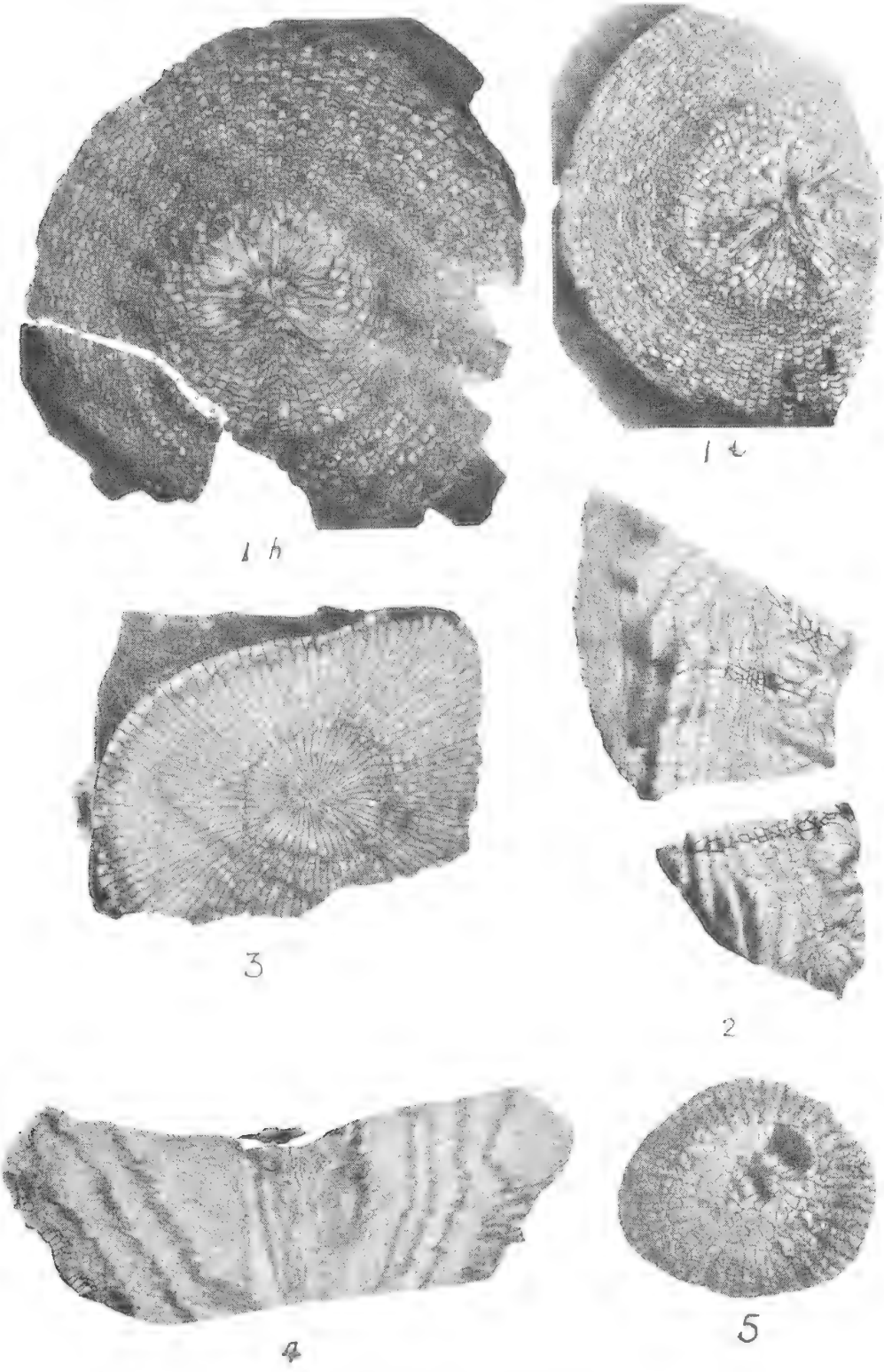
Fig. 5. *Xylodes yassense* (Eth. fil.) from Derrengullen Creek, Yass, N.S.W. Transverse section of the cylindrical type, × 3. Specimen in the Queensland University. Reg. No. F3164. Section No. 808.



Silurian Corals.—O. A. Jones.



SILURIAN CORALS.—O. A. JONES.



Silurian Corals—O. A. Jones.

THE CAMBRIAN FAUNAS OF NORTH-EASTERN AUSTRALIA.

Part 1: STRATIGRAPHICAL OUTLINE.
Part 2: TRILOBITA (MIOMERA).

By F. W. Whitehouse, Ph.D., M.Sc.
(Department of Geology, The University of Queensland. Palaeontologist to the Geological Survey of Queensland and the Queensland Museum.)

Plates VIII-X. Text-figures 1-4.

Part 1. STRATIGRAPHICAL OUTLINE.

(*a*) Explanation.

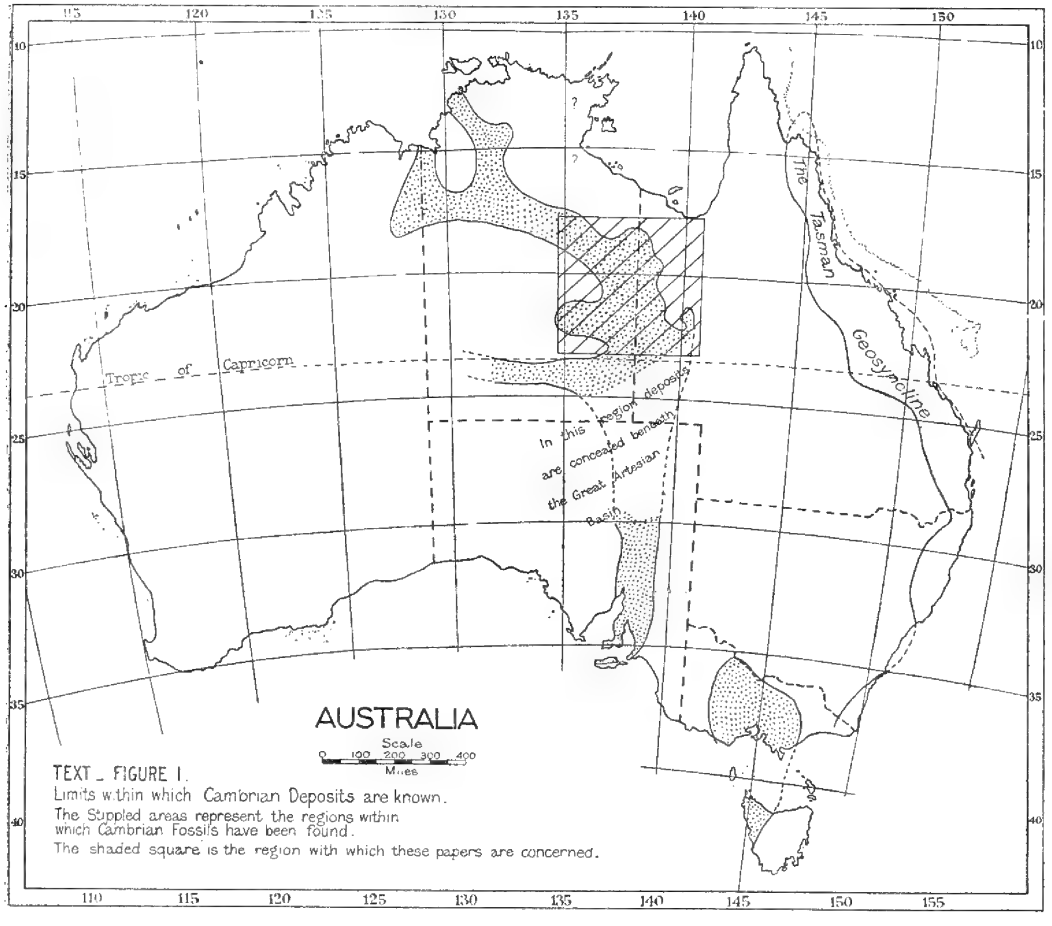
The Cambrian rocks of Australia lie in two large linear basins, and an outlying province in Victoria and Tasmania (text-figure 1). In the east of the continent, stretching along almost the whole of the coastal belt, is the Tasman Geosyncline, one of the greatest yet one of the least studied geosynclines of the globe. The uppermost beds, that range from Devonian to Permian in age, are richly fossiliferous. Below them is a colossal thickness of sediments from which few fossils are known. In the Brisbane region Denmead (1928, pp. 79, 83, 89 and 95) has estimated that this pre-Devonian portion of the section is not less than 75,000 feet thick. Some portion of these older beds must be of Cambrian age, but no Cambrian fossils have been recorded.

The other group of which more is known is a great, arcuate belt of sediments and volcanic rocks stretching from the Kimberley District of Western Australia to Adelaide and beyond in South Australia. Where Queensland, South Australia and the Northern Territory join, the outcrop of this belt is interrupted by later (Cretaceous) beds of the Great Artesian Basin. An east-west extension from the Cambrian beds runs through the Macdonnell Ranges, giving to the whole belt the shape of a reversed F.

In South Australia and in the Macdonnell Ranges the rocks of this belt are highly folded. But in the northern and larger portion the beds are little disturbed. Generally they are horizontal ; and they are so little changed that on several occasions they have been mistaken for Tertiary sediments. In this series of papers the faunas of the north-eastern portion of the province,[1] in western Queensland and the adjacent

[1] It has been difficult to select a succinct but adequate title for these papers. The term "north-eastern Australia" is not particularly satisfactory. Actually the area concerned is the region adjacent to and on both sides of the boundary between Queensland and the Northern Territory.

portions of the Northern Territory, will be described. Here with few exceptions the beds lie flatly, often perfectly so, and mapping of horizons is thus on a grand scale. Direct proof of succession of beds more often than not is wanting ; but from this region a series of index faunas has been found ranging from the top of the Lower to near the top of the Upper Cambrian. Provisionally it would seem that there is a conformable sequence of beds covering this greater part of the period.



TEXT - FIGURE 1.
Limits within which Cambrian Deposits are known.
The Stippled areas represent the regions within which Cambrian Fossils have been found.
The shaded square is the region with which these papers are concerned.

(*b*) Previous Records of Cambrian Faunas.

The geographical limits of the area with which I am concerned in these papers may be seen on the map that is text-figure 2. Here Cambrian beds cover an area of between 50,000 and 60,000 square miles, although a widespread development of loosely consolidated and relatively recent sediments (? Pleistocene) masks the full extent of the older beds. The records in literature of Cambrian rocks and fossils in this region are surprisingly few.

Cambrian fossils were first found in 1894 when H. Y. L. Brown, who then was Government Geologist of South Australia, obtained a trilobite from the spoil heap of a well five miles to the north of Alexandria Downs homestead in the Northern Territory. Brown placed this on record in the following year.[2] In 1897 the fossil was described by R. Etheridge Jr. as *Olenellus browni*.

In 1902 Etheridge described two more trilobites from the eastern part of the Northern Territory. These, which he named *Agnostus elkedraensis* and *Microdiscus significans*, had been found by A. A. Davidson in 1898 at a locality forty miles south east of Elkedra.[3]

The next record is in the year 1915 when Dr. H. I. Jensen (1915, pl. 4, figs. 2, 3), making no comment, figured a trilobite that had been obtained by A. L. Merrotsy eight miles east of Alroy Downs. This species was described by Etheridge in 1919 as a new species, *Ptychoparia alroiensis* (p. 385, pl. 40, fig. 8). It was unfortunate that three years later J. Mitchell (1922, p. 539, pl. 54, figs. 11, 12) gave the name *Ptychoparia merrotskii* sp. nov. using the same specimen as holotype.

In 1919 Etheridge summarised our knowledge of the Cambrian trilobites of Australia and discussed the affinities of all species known at that time.

Brown, in 1895, had commented on the widespread distribution in the Northern Territory of limestones similar to those from which the few Cambrian fossils had been found, and suggested that these beds were Cambrian. But the area is so sparsely settled that discoveries came slowly. A decade elapsed between the time of Merrotsy's discovery and the next find of Cambrian fossils. This was in 1924 when E. C. Saint-Smith placed on record the first Cambrian fossils found in Queensland. These were obtained by J. C. Miles on the Templeton River. The specimens had been referred to W. Dun for advice, and Saint-Smith in his notice quoted Dun's provisional determinations of the genera *Olenellus*, *Ptychoparia* and *Micromitra*. Dun suggested a Lower Cambrian age for the beds which Saint-Smith stated were intruded by the granites that are injected through the Pre-Cambrian.[4]

In 1927 I recorded from the same beds of the Templeton River *Eodiscus significans* (Eth. fil.), *Agnostus elkedraensis* Eth. fil. and species of *Dinesus* and *Notasaphus* (?) suggesting a Middle Cambrian age for the beds.

Two years later, in 1929, Chapman described a suite of fossils from the beds of the Templeton and Thornton Rivers. His list of determinations is as follows: *Lingulella marcia* Walcott var. *templetonensis* C., *Acrothele bulboides* C., *Agnostus*

[2] The references to these works will be found in the bibliography at the end of this paper, listed under the name of the author and the year of publication.

[3] This has been recorded by Davidson (1905) p. 6.

[4] I cannot verify the latter observation. The Templeton Series in this area appears to rest on the eroded surface of the granite.

chinensis Dames, *Bathyuriscus saint-smithi* C., *B. nitidus* C., *B. olenelloides* C., *Marjumia milesi* C., *M. conspicabilis* C., *M. elegans* C., *Dikelocephalus dunstani* C. and *Milesia templetonensis* C. Chapman regarded the beds to be "of Middle to Upper Cambrian age."

In 1930 I gave the name Templeton Series to these beds and recorded a lower horizon with *Redlichia*.

During the following year came the biggest advance in the collection of Cambrian faunas. Mr. B. Dunstan made valuable collections that are now the property of the Geological Survey of Queensland. Mr. C. Ogilvie recognised the importance of the widespread series for which he suggested the name Georgina Limestone. He searched for and found fossils in a number of localities in these beds. Following upon this, in 1931, I recognised the following faunal stages in the collections :—

(i.) A *Pagodia* Stage (upper part of the Upper Cambrian) with *Pagodia* (?), *Hyolithes*, *Eoorthis*, *Acrotreta* and *Lingulella*.

(ii.) A *Proceratopyge* Stage (lower part of the Upper Cambrian) with *Proceratopyge*, *Agnostus*, *Ptychagnostus*, *Pseudagnostus* and *Lingulella*.

(iii.) A *Leiagnostus* Stage (upper part of the Middle Cambrian) with *Agnostus*, *Leiagnostus*, *Obolus* and *Acrotreta*.

(iv.) A *Dinesus* Stage (lower part of the Middle Cambrian) with Chapman's fauna and the genera *Pagetia*, *Dinesus*, *Notasaphus* and *Paradoxides* (?).

(v.) A *Redlichia* Stage (upper part of the Lower Cambrian) with *Redlichia* and *Leperditia*.

These details were incorporated by David in 1932 in his summary of the Cambrian of Australia.

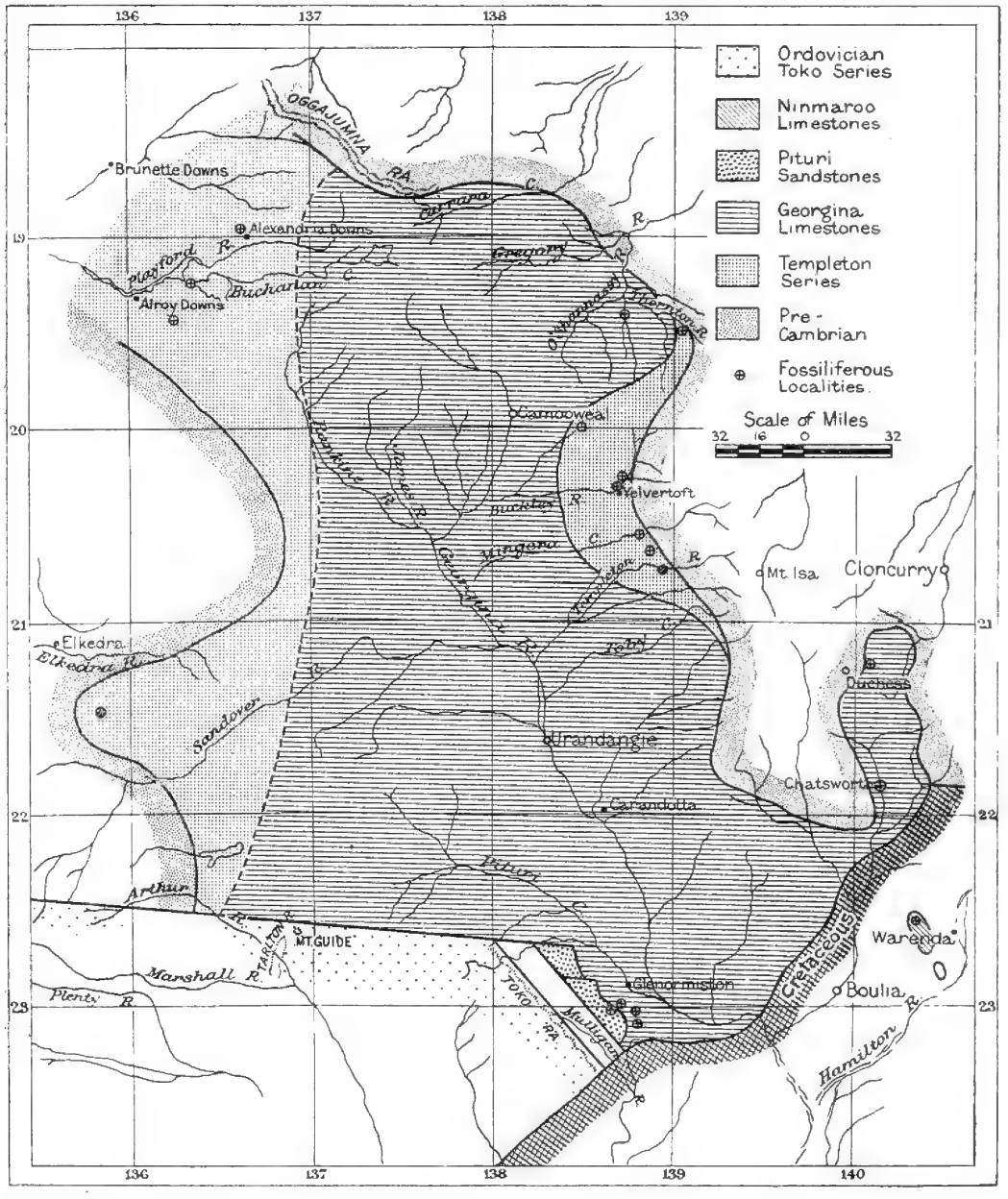
In 1931 Anderson published a photograph of a trilobite from the Templeton River[5]; and in 1935 Fletcher reproduced the same picture and gave some notes on the occurrence of the trilobite beds of the Templeton and Thornton Rivers.

The latest reference is by Kobayashi (1935b) who described and figured a trilobite from the Templeton River as *Dinesus ida* Eth. fil.

At intervals in the past four years I have been working in this field. Field work is difficult. The area is enormous, it is remote from the larger towns, and outcrops are spasmodic. Some of the region is desert land and is unoccupied. Even the best of the country is sparsely settled. On the Queensland side the area of each of the pastoral holdings is of the order of 3,000 square miles. In the Northern Territory the holdings are much larger, reaching as much as 13,000 square miles with Alexandria Downs. In addition to this I have been able to carry on the work only in the summer,

[5] *Xystridura saint-smithi* (Chapman).

a trying time when floods from the monsoonal rains in the north frequently hold up traffic and communications. Because of these things the field investigations are most incomplete. I had hoped to withhold publication of the palaeontological results until



Text-figure 2.—An interpretation of the Geology of the Georgina Basin. Deposits later in age than Cretaceous are omitted.

considerably more data were available. But field progress is slow and the palaeontological determinations already obtained have potential value for the correlation of other Australian areas, so that a series of papers, of which this is the first, has been prepared describing the faunas.

(c) Stratigraphical Details.

The basins of the Georgina River and most of its main tributaries lie in a great tongue of limestones with a general north-south elongation. To these beds the name Georgina Limestones has been given (Whitehouse 1931). The fossiliferous stages that are present show that the beds range from at least the *Phoidagnostus* Stage (equivalent to the *Paradoxides davidis* Zone of the Middle Cambrian) to the *Glyptagnostus* Stage (equivalent to the *Olenus* Zone of the Upper Cambrian). Conformably above them and representing other horizons of the Upper Cambrian are the Pituri Sandstones. On either side of the belt of the Georgina Limestones are beds with earlier faunas, ranging downwards to the *Redlichia* Stage at the top of the Lower Cambrian. In the east this lower group occurs in a circumscribed area in the basins of the Templeton, Thornton, Mingera and Buckley waters. These beds have been called the Templeton Series (Whitehouse 1930).[6] In the west outcrops are rare. That being so it would be premature to give to this group a separate series name. For the moment all such earlier beds are included under the name Templeton Series, and the two groups will be referred to as the eastern and the western developments of the Series.

The eastern development of the Templeton Series is entirely non-calcareous. The dominant rock types are sandstones, siltstones, cherts (many of which seem to be original siliceous deposits, not later replacements) and white to biscuit-coloured siliceous shales. These rocks, everywhere that I have seen them, are horizontal or nearly so. Unfortunately not far away, on the Great Artesian Basin, lacustrine Tertiary beds have much the same lithology in their sandstone and shale members. Therefore in the region with which I am concerned, where Tertiary beds may be and most probably are present and where outcrops are intermittent, sometimes it has been impossible to determine whether non-fossiliferous beds are Cambrian or Tertiary in age. It follows that it is not possible at present to state precisely how extensive are the beds of the Templeton Series. Neither is their thickness known.

On Yelvertoft Station the lowest beds, with *Redlichia*, may be seen resting on tilted Pre-Cambrian quartzites. Further to the south-east later beds with *Dinesus* occur and continue to the margin of the basin. On the divide between Mingera

[6] Bryan (1928, p. 58) has attributed the name Templeton Series to Dunstan. At the time when Bryan's work appeared the Geological Survey of Queensland, under Mr. B. Dunstan, anticipated publishing a new geological map of Queensland on which the name Templeton Series would be used for the Cambrian beds west of Mount Isa. This map was not published.

Creek and the Templeton River these beds rest on Pre-Cambrian granites and quartzites, so that apparently there is a considerable overlap of the *Dinesus* beds in this region. It may be mentioned that in their eastern limits, in the valley of the Templeton River, the *Dinesus* beds appear locally to be thrust over the Pre-Cambrian quartzites.

In its western development the Templeton Series rarely is seen outcropping. Usually fossils have been obtained from wells or from the silt-encrusted beds of the creeks. White and biscuit-coloured shales, identical with the matrix of the *Dinesus* beds in the east, are found with the same fossils. Unlike the eastern development the Templeton Series here contains limestones.

Although four faunal stages have been recognised in the Templeton Series only one of them, the *Dinesus* Stage, has been found widespread. The other three horizons are known at present each from but a single locality—the *Redlichia* Stage from Yelvertoft homestead, the *Amphoton* Stage from Split Rock on Waroona Creek, and the *Inouyella* Stage from No. 4 well on Alroy Downs.

Over an enormous part of the area in which they are developed the Georgina Limestones seem to be perfectly horizontal. The plateau nature of the Barkly Tableland, where they occur, in part may be due to this. Consequently, and due also to the deep pedocalcic soils of the region and the widespread development of late (? Pleistocene) deposits, outcrops are infrequent. Away from the Barkly Tableland, in the basins of the Thornton, Seymour and O'Shanassy Rivers, and also in the lower reaches of the Georgina, outcrops are more common. In these regions dips of varying degrees often are to be detected in the beds ; and no doubt it is due to this that outcrops are better. Generally such dips are small ; but in the north-east, near the junction with the Pre-Cambrian, dips up to 20° are seen commonly, while at two localities on Glenormiston in the south, along fault zones, there are dips of 60°.

In its northerly development towards the Oggajumna Ranges and also in the east (except in the region of the Templeton-Mingera-Buckley Basins) the Georgina Limestones rest upon the Pre-Cambrian complex. Such marginal junctions may be seen, for example, east of Duchess and also in the unnamed ranges in the basin of the O'Shanassy River where long ago Jack (1885, p. 9) recorded an unconformity between the Pre-Cambrian sandstones and the limestones. Furthermore Pre-Cambrian inliers occur in the limestones at a number of places, for instance on Glenormiston and Carandotta. From this it is suggested that, except in the Templeton-Mingera-Buckley area, the Georgina Limestones are transgressive across the Templeton Series on to the Pre-Cambrian. Nevertheless from the faunal analysis it would seem that, in spite of this transgression and the abrupt lithological change, there is little

possibility of a time break in the passage from the Templeton Series to the Georgina Limestones.[7] The relatively high dip of the limestones near their junction with the Pre-Cambrian in the Thornton River basin suggests some localised, marginal faulting.

There is a considerable variation in the limestone types in this series. White, cream and brown finely crystalline limestones are common. More closely grained types also are abundant, particularly a bluish type that has a very smooth texture. Such blue limestones are thick in the upper part of the section, in the beds with the *Proceratopyge* faunas. The texture of these rocks is so fine and the jointing so close that almost all the wells and bores sunk in them for water on Glenormiston Station have proved to be failures. Tyson's Bore, a failure on that property, penetrated limestones to its total depth of 1,810 feet; and tentatively this may be taken as a minimum thickness for these blue limestones in the upper part of the Series.

Just as, in the non-calcareous beds of the Templeton Series, difficulties in mapping have been caused by the similarity to adjacent shales and sandstones of Tertiary age, so in the region of the Georgina Limestones there are other hard, horizontal limestones of apparently Pleistocene age that are so similar to the Cambrian beds that mapping becomes difficult.[8] These later beds have been recorded in the north (Ball 1911, p. 17), but they are abundant also in the south (e.g. in the basin of Pituri Creek) as well as beyond the limit of outcrop of the Cambrian beds (on Warenda and Roseberth).

Within this region of the Georgina Limestones there are vast areas where the pedocalcic soils become so deep that the surface is a soil plain devoid of rocky outcrops. This is shown extremely in the south of the region in the area west of the border fence. Here the soil is so fine grained and non-cohesive in the dry weather that locally it goes by the name of "Bull Dust."[9] The extensive view northwards over these Bull Dust Plains from the northern scarp of the Tarlton Range is one of the most monotonously level prospects that I have seen.

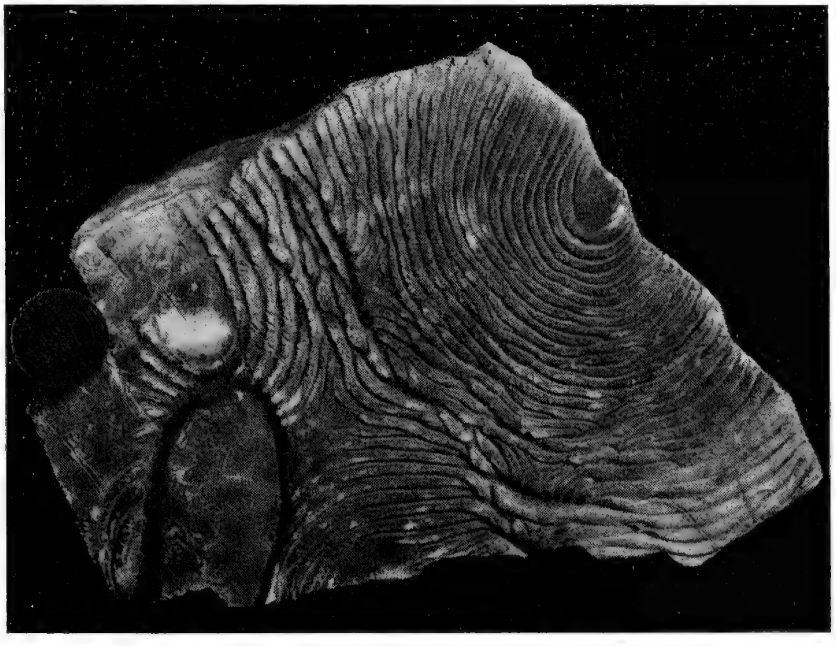
[7] An alternative explanation, but one that I do not favour, is that away from the type region the sediments of the Templeton Series grade laterally into the lower members of the Georgina Limestones. For the purpose of these papers it will be assumed that the Georgina Limestones are consistently later than the *Dinesus* beds.

[8] Several sections have shown that these beds are later than the lateritic soils of this region. It is interesting to note that on two occasions before the discovery of Cambrian fossils in Queensland, these western beds were mapped as late formations. Cameron in 1901, after Post-Tertiary gastropods had been found in the later limestones, mapped all the limestones of the Barkly Tableland as Post-Tertiary. Dunstan in 1920 mapped the whole of the Cambrian of Western Queensland as Jurassic. In 1872 Daintree, recording the presence of *Tellina*, suggested that the age of the limestones of the Barkly Tableland was Cretaceous. The confused nature of the evidence even as long ago as 1895, puzzled R. L. Jack.

[9] This soil is not confined to the Cambrian Limestones. South east of Birdsville, for example, it occurs on the Tertiary rocks capping the great Artesian Basin.

The thickness of the Georgina Limestones I am not yet able to determine, nor am I prepared at present to give a sequence of the various limestone types in the Series.

A feature of some importance is the presence of cherts in the sequence. Some of these are replaced limestones. Part at least of this replacement has taken place in late Tertiary or Post-Tertiary times ; for the relatively recent limestones also are affected, usually more completely than the Cambrian beds. But in addition to such secondary replacements there are cherts of primary deposition, occurring as peculiar, sausage-like masses along bedding planes, and as thin beds with curious, incised but superficial, concentric rings suggesting that they have been formed by the deposition of colloidal silica giving Liesegang structures. Such deposits are common also in the beds of the Templeton Series (text-fig. 3).



Text-figure 3.—Liesegang-like structures in Cambrian cherts from the Thornton River. ($\times \frac{2}{5}$).

From the basal beds of the Georgina Limestones I have not yet obtained fossils. The earliest faunas come from areas east of Camooweal and east and south east of Duchess. These belong to the upper part of the Middle Cambrian. Several faunal stages have been recognised with *Phoidagnostus* and *Anomocare*. Other fossiliferous stages occur a considerable distance to the south in beds at the top of the series. These have yielded faunas with *Proceratopyge* and *Pseudagnostus* that belong to the lower part of the Upper Cambrian. Curiously enough, although these

two fossiliferous regions are so far apart and have no faunal stages in common, there does not seem to be any chronological gap between the known stages of this part of the Queensland Cambrian.

In the western part of Glenormiston Station (which is in the southernmost part of the province) the blue limestones with *Proceratopyge* conformably are overlain by a series of sandstones and some siliceous shales to which the name Pituri Sandstones[10] is now given. Here the beds become horizontal in the southern part of their outcrop, a region of desolate, unoccupied sandstone country that sometimes gives rise to table-topped hills and sometimes is covered by the big, red sandhills of the desert. A little further north, in the basin of Wheelaman Creek, the sandstones have been faulted in a somewhat puzzling way, and there the beds have perceptible dips to the west.

The Pituri Sandstones have a minimum thickness of 100 feet. Fossils have been found only at one place in the Series—immediately west of Tyson's Bore on Glenormiston, in beds near the base of the sandstones. These have yielded the *Elathriella* fauna. One member of this is *Pseudagnostus*, a genus common to the upper stages of the Georgina Limestones, so that it would seem, in spite of the abrupt lithological change, that there has been no time break during this passage.

Further west no other Cambrian beds are known. Instead there are Ordovician beds, the Toko Series,[11] that begin with a rich cephalopod limestone containing *Actinoceras*, *Deiroceras*, *Calhounoceras*, "*Endoceras*," *Vaginoceras*, and several new genera allied to *Kochoceras*, *Armenoceras* and other boreal forms. Above these lie horizontal sandstones with asaphid trilobites. This appears to be a Middle Ordovician group, the cephalopod limestone being the equivalent of the Black River Stage in America.

Thus in this region no beds of Ozarkian (Tremadocian) or Lower Ordovician (Canadian) age have been found. From the straight line relationships with the Ordovician it would appear that it is a faulted junction,[12] the fault striking 320° E. of

[10] The aborigines of the Idamea and Toko tribes that inhabited Glenormiston Station did considerable trading with other tribes in the relatively rare plant, *Duboisia Hopwoodi* (von Mueller), the native name for which is Pituri. The plant was valued for its narcotic properties, due to the alkaloid Duboisine. Pituri Creek is named after this plant, although it is not known to have grown in the basin of this waterway. The plant, now very scarce in Western Queensland, was once common in the south of Glenormiston and in the basin of the Mulligan River. Part of these sandstones lie in this region ; and in the absence of appropriate place names (the aboriginal names are very long) I have selected the name Pituri Sandstones for the Series.

[11] I propose this term to replace "Glenormiston Series" (Whitehouse 1930), since, although the series occurs on Glenormiston, the greater part of that property is occupied by Cambrian beds.

[12] No contact is visible. In front of the scarp of the Toko Range there is a long, alluvium-filled valley worn out along the junction. For reasons that it is hardly appropriate to discuss in this paper I believe that there is a trough fault along the junction.

N. But the gap is bridged to some extent by deposits further to the east, in a series of inliers in the Cretaceous. On Warenda Station east of Boulia there are three large hills—Black Mountain (Unbunmaroo), Ninmaroo and Mt. Datson. These consist of folded limestones of considerable thickness and identical in appearance with the Georgina Limestones. Platy blue limestones precisely similar to those of the Georgina group abound in the lower part of the section. Higher beds have yielded *Eoorthis* and a colossal wealth of echinoderm ossicles. For a considerable thickness these beds are so matted with pelmatazoal plates that they form typical echinodermal limestones. This series I propose to call the Ninmaroo Limestones. In one bed high up in the section on Black Mountain I have found a great wealth of ellesmereoceratid cephalopods, suggesting that these beds belong to the Lower Ozarkian (Lower Tremadocian). I have found no trilobites with them ; and the beds so very thick above and below this horizon have not yielded fossils significant for precise correlation. A considerable portion of the Tremadocian no doubt is represented by these limestones.

Thus there is an alternation of lithological types :

Ninmaroo Series	Limestones
Pituri Series	Sandstones and shales
Georgina Series	Limestones
Templeton Series	Sandstones and shales

The changes are abrupt ; for, excepting the western development of the Templeton Series, the formations are either wholly calcareous or (except for the cherts) entirely non-calcareous. Yet in spite of this it is to be doubted whether there is any gap in the succession unless possibly at the base of the Ninmaroo Limestones.[13] There is a remarkable series of faunas that can be correlated individually with zones elsewhere ; and the only important gaps in the faunal succession correspond with the unsearched portions of the sequence. This continuity is stressed by the deposition of similar, primary cherts through the Templeton and Georgina Series.

There seems to have been certain marginal faulting in the series as indicated above. In addition two great faults extending roughly east and west occur on Glenormiston. One of these appears to extend for a colossal distance in the Northern Territory, abruptly separating the horizontal Toko Series of the Toko Range, the Tarlton Range and so on, from the Cambrian areas of the Bull Dust Plains in the north. The question may be raised whether this presumed fault is a lateral

[13] There is a small outcrop of gneiss at the base of Black Mountain. Although this may be a small inlier (and such inliers are known in the Georgina Limestones) it may be suggested that, in Tremadocian times, the basin of deposition has shifted laterally to the east. Another possibility that must be kept in mind is that the lower part of these limestones is equivalent to the Georgina Limestones and that the Pituri Sandstones may be present but have not yet been seen.

continuation of the east-west disturbances of the Macdonnell Ranges. It may be a long while before this problem is solved. These faults, with the folding of the Ninmaroo Limestones and the fault that divides the Cambrian from the Ordovician on Glenormiston, are the only evidences of tectonic disturbance that I have seen in the region.

(*d*) On the Use of the Term Cambrian.

For several reasons it is not easy to delimit the Cambrian development in Australia. One of these is the uncertainty about the base of the Cambrian. Trilobite faunas are first known in the Cordilleran region of North America (*Nevadia* Stage). The earliest Cambrian beds in the Atlantic Province have no trilobites either in Europe or in North America. Preservable trilobite faunas would seem not to have reached that region until later in the Lower Cambrian (*Holmia* Stage). In the province represented by Asia and Australia, which faunally is a unit in the earlier though not in the later parts of the period, the appearance of such faunas was even further delayed, and no trilobite faunas are known earlier than the *Protolenus* Stage although appropriate lower beds, suitable for preserving fossils, occur.

In Australia we do find earlier although non-trilobitic faunas. The most important of these are the archaeocyathinae. But the occurrence of the archaeocyathinae seems so definitely to be determined by climatic factors that, as David (1927) has shown, their stratigraphical position varies considerably in different parts of the globe.

Generally in Australia the base of the Purple Slate Series of South Australia is taken as the base of the Cambrian. It is an acceptable choice ; and in the absence of more definite evidence it serves. The problem of defining the base of the Cambrian does not arise in the area with which I am now concerned, for Cambrian beds earlier than the *Redlichia* Stage do not appear to be present.

A further difficulty is the disagreement between various workers in other lands about the top of the Cambrian.

In 1879, as a compromise between the views of Murchison and Sedgwick on the Lower Palaeozoic relationships, Lapworth proposed the term Ordovician as a period name. He suffered as many intermediaries do ; and today on the continent of Europe the term Ordovician is used not as a period name but as a subdivisional term within Silurian.

In English speaking countries the acceptance of a separate period did not overcome the difficulties of the time, for the limits of the periods were defined on local (English) lithology and diastrophism. Faunal gradations were noted and a number of workers preferred to transfer the uppermost stage of the Cambrian (the

Tremadocian) into the Ordovician. Often it has been stressed since Lapworth's paper that acceptable world-wide divisions should be based on palaeontological grounds. Particularly is this necessary with modern methods of research, and particularly is that need urgent in remote lands like Australia. It is doubtful if a "natural" palaeontological division between Cambrian and Ordovician exists. The base of the Arenig, which Lapworth proposed as the base of the Ordovician, happens to be useful for brachiopod workers since at this stage there is a marked increase in the development of the orthids and strophomenids. For workers on trilobites it is also fairly convenient; but it is not so suitable for those who work on the graptolites.

The assumption that there is a natural division for all faunas is probably unreasonable and certainly unproved. Resser's recent work (1933) on Cambrian horizons is a welcome attempt to clarify the position within the Cambrian. But some international council is needed to define the major boundaries on definite though perhaps arbitrary palaeontological premises, after which, except in special and approved emergencies, no interpolation should be necessary but only subdivision. Almost any horizon would do so long as it is definite.

In 1911 Ulrich complicated the question further by proposing to recognise two other periods between the Cambrian and the Ordovician—Ozarkian and Canadian were the names he chose. As with Lapworth's term Ordovician these new names originally were defined for lithological rather than palaeontological groups. In America the terms have been adopted; but with few exceptions (Kobayashi, Poulsen, Spath and Teichert for instance) they have not been used abroad. Even in America the usage generally is not that originally proposed by Ulrich.[14] Many prefer to take the less debatable viewpoint and, in using the terms, to apply them to subdivisions of pre-recognised periods—Ozarkian as the uppermost division of the Cambrian and Canadian as the basal stage of the Ordovician. As such it is doubtful whether internationally the term Ozarkian strictly has any standing, since on grounds of priority the name Tremadocian takes precedence. Nevertheless it is more convenient than Tremadocian in that it is rather more definitely defined on palaeontological lines. Furthermore it is appropriate since the other major divisions of the Cambrian bear American names.

To depart as little as possible from traditional usage I am adopting in these papers the following nomenclature :—

Ordovician		(Basal Zone—*Dichograptus*)
Cambrian	Ozarkian	(Basal Zone—*Acerocare*)
	Croixian	(Basal Zone—*Agnostus pisiformis*)
	Acadian	(Basal Zone—*Paradoxides oelandicus*)
	Waucobian	(Basal Zone—*Nevadia*).

[14] For a recent statement of his viewpoint see Ulrich, 1924, p. 83.

Ozarkian plus Croixian is the Upper Cambrian in the English sense. Croixian alone is Upper Cambrian in some recent American usage.

For convenience I have used the Scandinavian zonal nomenclature, since there is a pertinent comparison between many Australian and Scandinavian Cambrian faunas. Resser in his valuable paper of 1933 indicates how these zones compare with the Cordilleran sequence.

(*e*) Notes on the Faunal Stages.

In this little-searched region of nearly 60,000 square miles fossils have been found at only twenty two localities.[15] No less than nine of the twelve faunal stages that now are recognised are known each from the collections from but a single place. A prolonged and systematic search of the sediments will multiply the number of fossiliferous localities and surely also the number of faunal stages. Yet, curiously enough, the faunas that we know cover so aptly the gamut of the beds that few of the pertinent zones in the Scandinavian sequence seem not to be represented. The historical review of our knowledge of these beds shows a progressive addition to the number of faunal stages known since 1929, until which time only the one faunal group had been recognised. Collecting will go on ; and perhaps before long these beds will provide a faunal progression that will enable us to make a zonal subdivision more detailed than has been possible in the very condensed sequences of Scandinavia, Shropshire and Newfoundland.

I have stressed the value of the Scandinavian comparisons. Resser recently has urged (1933) that a world-wide zonal nomenclature should be based on American usage. That I think will be so in the future ; but the zonal positions of some of the significant faunas of western North America are still uncertain. Time will show which is the best sequence for universal usage. For the present a comparison of the Australian succession with the Scandinavian zones serves most purpose with most of the faunal stages here recorded. In the earlier part of the Cambrian the Australian faunas are closely akin to those of southern and central Asia. But the *Dinesus* Stage marks the coming of a great change in relationships. Thereafter, from about the middle of the Middle Cambrian, there is a curiously close agreement of our faunas with the boreal group of Scandinavia and Siberia. Further comment on this aspect is postponed for the present ; but it is worthy of mention that, in many periods of the Palaeozoic and Mesozoic when Australian faunas and floras closely may be compared with groups elsewhere, the close analogies are either with the areas remote from the present equator or else (as in the late Palaeozoic) with intermediate areas that appear to have been cold. Probably until the close of the Mesozoic Australia was one of the colder regions of the globe.

[15] From Chatsworth homestead, one collecting place, the nearest locality from which fossils have been found in a southerly direction is on Glenormiston, 125 miles distant to the south-west.

Most of the localities from which our fossils have come are separated one from another by many miles of country. That being so, when the beds lie so flatly, the stratigraphical succession of the horizons has been determined not by direct observation but by faunal comparisons with sequences elsewhere. In one or two instances, and these are reviewed in the paragraphs that follow, the order of succession of a few related faunas is in doubt. Generally, however, the Scandinavian succession has provided a key to the sequence here, and the sequence so determined has at present no inconsistencies. The review that follows is brief because it is preliminary. It is inopportune to discuss correlations in greater detail until the evidence of the later papers in this series has been presented.

i. The Redlichia Stage.—Beds with *Redlichia* occur elsewhere in Australia (The Flinders Range, the Kimberley District and the north-west of the Northern Territory). But in the area concerned they have been found at only one locality, Yelvertoft homestead. Species of *Redlichia* and *Aluta* are the only forms known. The types of *Redlichia* that are found in these beds occur in Asia at the top of the Lower Cambrian. The equivalent horizon in Europe and North America would be above the *Protolenus* beds where, on both sides of the Atlantic, there appears to be a gap in the sequence. Other Australian faunas are so like those of the Atlantic Province that I would expect *Redlichia* to be found in the latter region if a complete sequence were available. *Redlichia* occurs above *Protolenus* in China (Saito, 1934) and also, it may be noted, in Australia.[16]

The three faunal stages that follow (the *Amphoton*, *Inouyella* and *Dinesus* Stages) appropriately may be bracketed as the *Kootenia* Group. *Kootenia* occurs with *Dinesus* in all three countries where it is known—Queensland, Victoria and Siberia.[17] A doubtful *Kootenia* is found with *Inouyella* in the Northern Territory and the two genera are associated in China. I have not found *Kootenia* in the *Amphoton* Stage of Queensland; but Mr. W. E. Schevill, of the Museum of Comparative Zoology, Harvard, informs me that, in the collections that he made from the type locality of the Stage, Dr. T. Kobayashi has identified *Dorypyge* which possibly represents the same genus. Furthermore in the collections of the University of Queensland from the Heathcotian beds of Knowsley in Victoria I have recognised the same two trilobites that here are recorded from the *Amphoton* Stage in Queensland.

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[16] The rich and varied trilobite fauna at the top of the Archaeocyathinae limestones in South Australia includes several species of *Protolenus*, one of which is the inadequately figured *Ptychoparia howchini* Etheridge Jr. (1919, p. 385, pl. 40, fig. 7). *Redlichia* occurs at a higher horizon in the series.

[17] The Siberian *Solenopleura* (?) *sibirica* (Schmidt) as figured by von Toll (1899, p. 36, pl. 2, figs. 12, 13, and 16) is a typical *Dinesus* occurring with *Kootenia slatkowskii* (Schmidt). *Notasaphus* (Gregory 1903, p. 155) I regard as a synonym of *Kootenia* Walcott.

Mr. D. E. Thomas informs me that these fossils are from his " Dolichometopus Band " in which he finds *Kootenia*[18] (Thomas, 1935, p. 92).

The three faunal stages thus are closely allied. There is, however, no direct evidence of the order of succession. In our province, although *Dinesus* beds are widespread, the *Amphoton* and *Inouyella* Stages are known each from a single locality many miles removed from other places where fossils have been found. *Amphoton* and *Dinesus* beds are associated in Victoria ; but whereas in Queensland they are too nearly horizontal for the stratigraphical order to be determined, in Victoria, so I understand, they are too nearly vertical for this to be decided. In Asia, the only other continent where they are recorded, *Amphoton* is found in China and *Dinesus* in Siberia, so that again there is no direct evidence.

In China *Amphoton* occurs in the early part of the range of the *Dorypyge-Kootenia* assemblage and even begins before it. So I have interpreted the *Amphoton* Stage as being earlier than that with *Dinesus*. Some confirmation of this is given by the fact that agnostids have not been found in the *Amphoton* Stage either in Queensland or in Victoria. Agnostids seem to make their first appearance in Australia in beds of the *Dinesus* Stage. The *Inouyella* Stage also has not yielded agnostids. This combined with the fact that it has elements of both the *Amphoton* and *Dinesus* faunas suggests that it occupies an intermediate position. In Victoria, according to Thomas (1935, p. 93),there are not more than 500 feet of strata separating the *Amphoton* (*Dolichometopus*) beds from those with *Dinesus*. It will be interesting to see whether the *Inouyella* fauna will be found in this interval.

ii. The Amphoton Stage.—From Split Rock, on the main road crossing of Waroona Creek between Camooweal and Mount Isa, soft, yellow siltstones have yielded *Amphoton*, together with a new genus of trilobites and another of brachiopods. As mentioned elsewhere the two trilobite genera are associated also in Victoria. *Dorypyge* (*Kootenia* ?) so I understand from Mr. W. E. Schevill, is also present although I have not collected it.

iii. The Inouyella Stage.—From No. 4 well on Alroy Downs a fauna was obtained in limestones and calcareous shales. This had *Inouyella*, *Lorenzella*, *Anomocarella*, *Kootenia* (?), *XYSTRIDURA* (nom. nov.),[19] *Westonia* and the new genus of brachiopods that is present also in the *Amphoton* Stage.

iv. The Dinesus Stage.—A very rich fauna wonderfully well preserved is found on the Templeton River, about 14 miles west of Mount Isa. Brachiopods, conularida and sponges ("*Protospongia*") are plentiful. The trilobites include species

[18] Recorded as *Notasaphus*.

[19] *XYSTRIDURA*, nom., nov. is proposed to replace *Milesia* Chapman (1929, p. 214) which is invalidated by *Milesia* Latreille (1804). *Olenellus browni* Etheridge fil. (1897, p. 13, pl. 1, fig. 1) is selected as genotype.

of *Diplorrhina*, *Triplagnostus*, *Hypagnostus*, *Cotalagnostus*, *Pagetia*, *Dinesus*, *Kootenia*, *Paradoxides* (?), *Xystridura*, *Oryctocephalus*, and *Ptychopariidae*. Of these *Xystridura* is the most abundant. This appears to be the earliest stage that has yielded agnostids either in North-eastern Australia or in Victoria. In Queensland they are varied in genera and prolific in individuals. Equivalent beds with some of this fauna are widespread in the basins of the Thornton, Templeton, Mingera and Buckley waters in Queensland. In the western development of the Templeton Series fossils have been found on Elkedra, Alroy Downs and Alexandria Downs.

The correlation of the stages of the *Kootenia* Group with the zones recognised in other countries is difficult. During this development our Australian faunas are most similar to those of Asia where the zonal positions of the Middle Cambrian faunas are not yet adequately decided. *Kootenia* ranges through a considerable portion of the Middle Cambrian. Since much of the upper part of the Middle Cambrian is represented in the *Anomocare-Phalacroma* beds of the Georgina Limestones and since no fossils have been collected from the basal members of that limestone series it would appear that the *Kootenia* Group should be regarded as equivalent to the basal members of the Middle Cambrian. I would suggest tentatively that the three stages of the group cover the three basal zones of the Middle Cambrian (*Paradoxides oelandicus*, *Triplagnostus atavus* and *Ctenocephalus exsulans*). The abundance of *Triplagnostus gibbus* in the *Dinesus* Stage suggests that these beds represent the uppermost of these three zones.

The stages that have been discussed are in the Templeton Series. As I have just stated no search has been made in the earliest beds of the Georgina Limestones. Collections from these horizons might be expected to yield faunas of other zones.

The three faunal stages that follow, like the three preceding, appropriately might be bracketed together. For this assemblage I suggest the name *Phalacroma* Group.

v. The Phoidagnostus Stage[20].—In the limestones at the margin of the basin eight miles north-east of Duchess *Solenagnostus*, *Enetagnostus*, *Lejopyge*, *Phoidagnostus*, *Phalacroma* and *Lisania* are abundant with brachiopods and "*Protospongia*." In Europe *Enetagnostus* and *Lejopyge* are found in the zones of *Paradoxides davidis* and *P. forschammeri*, *Lejopyge* continuing further into the zone of *Agnostus laevigatus*. *Phalacroma* ranges from the zone of *P. tessini* to the zone of *P. forschammeri*, *Phoidagnostus* occurs in the last-named zone. The beds with *Anomocare* in Queensland, which appear to represent the zones of *P. forschammeri* and *Agnostus laevigatus*, have *Phalacroma* but it is rare. The Duchess beds, in which

[20] Referred to previously (Whitehouse 1931) as the *Leiagnostus* Stage. The reason for the change of name is given later under the section on *Phalacromidae*.

Phoidagnostus and *Phalacroma* are abundant and of generalised types, are presumably slightly earlier and may be correlated with the Zone of *Paradoxides davidis*.

vi. THE ANOMOCARE STAGE.—At the road crossing of Harris Creek north-east of Camooweal there are limestones containing *Anomocare* very close to the genotype. *Euagnostus* and brachiopods occur with it and one specimen of *Phalacroma* has been found. In Europe *Anomocare* appears to be restricted to the Zone of *Paradoxides forschammeri*, with which this stage may be correlated.

vii. THE SOLENOPLEURA STAGE.—This is an unsatisfactory name but must serve for the present. It is used for a fauna found at Chatsworth homestead that contains *Pseudagnostus*, *Anomocare*, *Solenopleura* (?) and brachiopods. In other countries *Pseudagnostus* is recorded no lower than the Upper Cambrian. The coexistence of this genus with *Anomocare* (of a type rather different from that of the genotype) suggests that the horizon is the Zone of *Agnostus laevigatus*. Except at Vestergötland this zone in Europe carries few fossils.

Such a great distance separates the localities that have yielded the *Anomocare* faunas from those where higher faunas have been found that it might be expected that a number of unrecognised faunal stages may be present in the beds of the intervening area. But, curiously enough, none of the Scandinavian zones of this part of the sequence appear to be unrepresented. The stages that follow, and which represent the upper part of the Georgina Limestones, may be bracketed as the *Proceratopyge* group. *Pseudagnostus* (characteristic of the lower part of the Upper Cambrian) occurs in them with *Proceratopyge*. In Scandinavia *Proceratopyge* ranges through the three lowest zones of the Upper Cambrian. In America, under the name *Housia*, it occupies a similarly low, Upper Cambrian position.

viii. THE ANORINA STAGE.—About four miles north of the twenty-mile bore on Glenormiston, the beds with *Pseudagnostus* and *Proceratopyge* are crowded with fossils. In addition to these two genera I have collected *Corynexochus*, *ANORINA* gen. nov.[21] and a new genus of trilobites that may be a derivative of *Anomocare*. It is rather like certain Siberian forms described by Schmidt.[22] Brachiopods and "*Protospongia*" also are abundant. In Scandinavia only one specimen of *Anorina* (*A. superstes* Linnars. sp.) has been found. This came from either the top of the *Olenus* Zone (Moberg 1910, p. 55) or else from the zone of *Orusia lenticularis* immediately above (Westergaard, 1922, p. 182). What its full European range might be in the early part of the Upper

[21] *ANORINA* gen nov., genotype *Liostracus* (?) *superstes* Linnarsson (1875, p. 498, pl. 22, figs. 6, 7). The genus is closely similar to the Middle Cambrian *Anoria* Walcott, which recently has been revised by Resser (1935, p. 10) but differs from it in having a non-expanding glabella and non-tuberculate thoracic segments.

[22] *Anomocare pawlowskii* Schmidt and *Liostracus maydelli* Schmidt. (*See* von Toll, 1899).

Cambrian cannot therefore be stated. I believe that the Queensland fauna with *Anorina* is at the base of the Upper Cambrian since it contains not only *Proceratopyge* (ranging downwards to the base of the Upper Cambrian) but also typical *Corynexochus* that in Europe comes to the top of the Middle Cambrian but is not recorded later. Therefore I suggest that this stage represents the Zone of *Agnostus pisiformis*.

ix. The Glyptagnostus Stage.—At several places from seven to nine miles north of the twenty-mile bore on Glenormiston the blue limestones have yielded only *Glyptagnostus*, *Pseudagnostus*, *Proceratopyge*, and *Olenus* together with brachiopods. *Glyptagnostus* in Scandinavia is confined to the *Olenus* Zone, which is within the range of *Proceratopyge*. In Wales it appears to be on the same horizon. These Queensland beds therefore may be correlated with the *Olenus* Zone.

x. The Pagodia Stage.—In the cabinets of the Geological Survey of Queensland there is a suite of fossils collected by the late Mr. B. Dunstan from fourteen miles south of Glenormiston homestead. The genera present include *Pagodia*, *Eoorthis*, *Hyolithes* and *Lingulella*. Palaeontologically the fauna gives little indication of the precise horizon within the Upper Cambrian ; but from the geographical position of the locality the beds would appear to be near the top of the Georgina Limestones. I have searched for but have not found this fauna at the locality stated by Dunstan. From the uppermost beds of the Georgina Limestones, however, I have obtained a new genus of Olenidae.

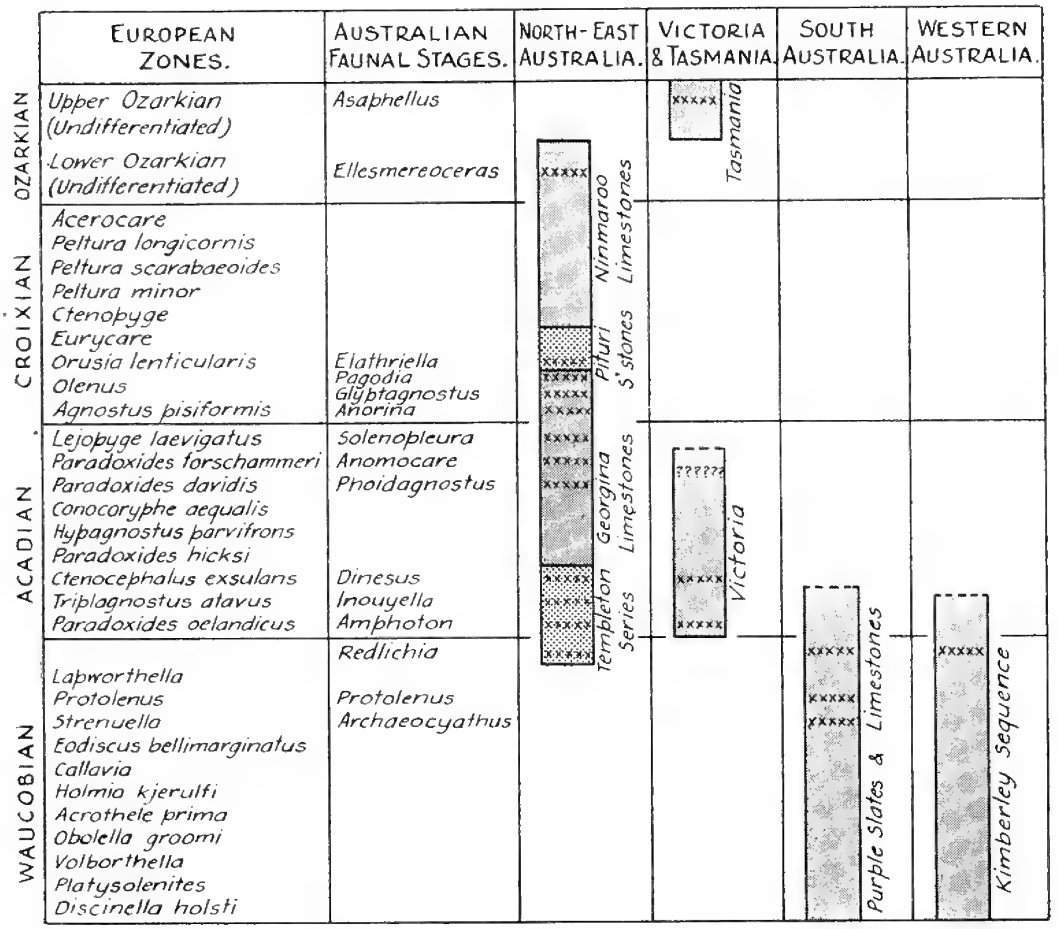
xi. The Elathriella Stage.—In the lowest beds of the Pituri Sandstones immediately west of Tyson's Bore on Glenormiston I have found *Pseudagnostus*, *Aspidagnostus*, *Olenus* (?), *Elathriella*, *Pesaia* (?) and *Orusia*. The olenid is typical but has rather a wider frontal brim than in the recorded species of *Olenus*. This and the *Pseudagnostus* ally the beds to the underlying *Proceratopyge* Group, suggesting that there is no break in the succession. I would suggest tentatively that this fauna belongs to the Zone of *Orusia lenticularis*.[23]

xii. The Ellesmereoceras Stage.—Some years ago in the Ninmaroo Limestones of Black Mountain, Warenda, Mr. C. Ogilvie found a fauna of abundant echinoderm ossicles and *Eoorthis*. Subsequently I collected the same forms on Mt. Datson. Recently in examining the Black Mountain section I found in beds slightly below the *Eoorthis* horizon a great wealth of ellesmereoceratid cephalopods. No trilobites were found with them. I have not had the opportunity subsequently of re-examining the Mt. Datson section to look for this fauna which is the only determinative assemblage yet found in the thick Ninmaroo Limestones. Ellesmereoceratidae occur in the Lower Ozarkian in many regions. Beyond that, at the moment, it is not possible to make a closer zonal comparison.

[23] *Elathriella* hitherto has been recorded only from Greenland. No other species were found in the same bed. Poulsen (1927, p. 244) was not certain where to place such a new form and tentatively suggested a Lower Ozarkian horizon.

Closing these remarks I would point out that several of the stage and group names here adopted are not perfectly satisfactory so that on some later occasion it may be expedient to change them for more appropriate terms.

As text-figure 4 I give a table of suggested correlations of the Cambrian horizons of Australia. This has been based on a re-examination of the faunas from all the Australian horizons except the Dolodrook Limestone of Victoria and the beds of the Kimberley District. These latter collections, housed in the National Museum (Melbourne), have not been available to me.



TEXT. FIGURE. 4.

SUGGESTED CORRELATION OF AUSTRALIAN CAMBRIAN HORIZONS.

Part 2. PALAEONTOLOGY.

Subclass TRILOBITA Walch 1768.

Order MIOMERA Jaekel 1909.

I have used Jaekel's classification of the trilobita into Miomera and Polymera, believing that it best expresses the major natural divisions of the group.

The small agnostid and eodiscid trilobites with large head and tail shields and few thoracic segments differ so strikingly from the other groups that they require separate placing. No transitions have been recorded between these two major divisions. Furthermore, even among the large trilobites with many thoracic segments and variable pygidia (the Polymera of Jaekel), there are many natural divisions that cannot be joined at present by known connecting links. The Lower Cambrian polymerid trilobites, for instance, include the blind Mesonacida (which lead apparently to Redlichiidae and Paradoxididae) in which the pygidium is tiny, and Corynexochidae with eyes and large pygidia. No intermediate forms are known. Ellipsocephalidae also is isolated.

There must have been a long Pre-Cambrian ancestry of the trilobites during which the segments of the head fused to form the compact shield that we know. Jaekel (1901) has suggested how this fusion may have taken place. According to this idea there were eight segments in the cephalon represented by the hypostome, the rostrum, five glabellar segments and the occipital ring.

The larval stages of *Elliptocephala* (Walcott 1910) suggest that the palpebral structures are pleural developments of which the axis is the first glabellar lobe, and that furthermore the post-palpebral portions of the fixed cheeks are the pleura of the remaining glabellar segments. I prefer to believe that the segments of the head were as follows :—

1. The hypostome.
2. The rostrum.
3. The pre-palpebral fixed cheeks to which the free cheeks are the pleura.
4. The 1st glabellar lobe and the palpebral structures.
5-7. The 2nd to 4th glabellar lobes and the post-palpebral portions of the fixed cheeks.
8. The occipital structures.

Considering that there must have been a long period for the fusion of the cephalon, whatever be the details of the fusion, and remembering the variety of the trilobite groups when first they are known in the Lower Cambrian, it is reasonable to suggest that the early trilobite stock had a soft carapace and that independent lineages separately developed hardened tests. The strange and isolated genera *Marella*

Walcott[24] of the Middle Cambrian and *Mimetaster* Gürich (1930) of the Devonian, each with little hard carapace, suggest that at least until the Devonian soft forms may have persisted and that they developed offshoots that were slightly more specialised than the trilobites.

The trilobites with hard dorsal tests vary within wide limits. Anagenetic and catagenetic changes simultaneously operate on separate divisions of different lineages. Some forms become smooth by the elision of surface detail while related forms increase their ornament. Glabellar furrows increase and diminish. Eyes appear and disappear. The number of thoracic segments varies, and so on. If there has been this variation in palaeozoic periods when hard-shelled forms occur it is well to suppose that it operated previously. Thus it is only to be expected that the earliest known trilobites belong to a number of circumscribed and differentiated groups.

I would suggest that in Pre-Cambrian times the soft ancestors of the trilobites separated into at least two major groups. One of these, a short-lived section, developed hard tests in two main lineages (Eodiscidea and Agnostida) and are preserved as the Miomera. In the other, in which there was considerable variation, tests developed in several lineages. One of these (Mesonacida) like Miomera, was blind when their earliest testiferous members appeared, but facial sutures later arose along an old fusion line. In others (Corynexochidae, Ellipsocephalidae, Menomonidae, Burlingidae, etc.) the development of facial sutures preceded the hardening of the test. It may be that certain post-Cambrian families independantly arose from the soft polymeran stock ; but further discussion of these relationships is postponed to other occasions.

Within Miomera there are two major divisions—Eodiscidea that originally has three thoracic segments, though in some forms (*Pagetia*) they may be reduced to two, and Agnostida which always has two segments in the thorax. Both groups are present in north-eastern Australia.

Suborder Eodiscidea Richter.

Eodiscids first appear in the Lower Cambrian. The typical form of the group is a small, blind trilobite with subequal, subcircular cephalon and pygidium and with three segments in the thorax. In the Middle Cambrian specialised forms develop facial sutures and palpebral structures. Of these *HEBEDISCUS* gen. nov.[25] and

[24] Dacque (1921, p. 703) and Ruedemann (1931, p. 9) each has suggested that *Marella* is a trilobite in the period of ecdysis. The anterior appendages, however, suggest that it is a variant from the trilobite stock.

[25] *HEBEDISCUS* gen nov., genotype *Ptychoparia attleborensis* Shaler and Foerste (1888, p. 39, pl. 2, fig. 14), has strong palpebral ridges and lobes, traces of glabellar furrows and proparian facial sutures. The pygidium is smooth, with a strong axis extending to the posterior rim. Cobbold (1931, p. 462, pl. 38, figs. 1-6), who referred the genotype tentatively to *Pagetia*, figured a complete form showing that there were three segments in the thorax.

Delgadoia Vodges[26] retain the three thoracic segments but *Pagetia* has only two. *Dipharus* Clark (1923, p. 478) has been included in Pagetiidae by Kobayashi (1935b, p. 112). It is so small that possibly it is a larval form. It may be the immature stage of a pagetiid, as Cobbold (1931, p. 465) has suggested. But equally well it could be the larval stage of a polymerid trilobite.

The genera of the eodiscids that are known to have had eyes and facial sutures differ considerably. *Delgadoia*, with simple shields, is similar in many ways to the blind *Weymouthia*, differing in having eyes and faint axial structures. *Pagetia* differs from *Calodiscus* only in the eye structures and in the reduction of the number of thoracic segments from three to two. *Hebediscus*, which retains the eodiscid features of a tuberculate rim and three thoracic segments, is an even more specialised form. It has well developed palpebral ridges and glabellar furrows that make it more like a polymerid trilobite than any other member of the Miomera. *Pagetia* also has these structures, though they are somewhat spasmodically developed, so that possibly *Pagetia* and *Hebediscus* are not far removed genetically. *Delgadoia* differs so much from them and resembles closely certain blind members of the group that it is probable that the eodiscids with facial sutures have arisen polyphyletically from the blind forms of the suborder. In Pagetiidae, which most nearly concerns me at the moment, I include only *Pagetia*.

Blind eodiscids have not been found in Australia, so that there is no need to comment upon them here. I would merely record that I agree with Etheridge (1919, p. 383) that *Microdiscus subsagittatus* Tate (1892, p. 187), from the Lower Cambrian (*Protolenus* Stage) of South Australia, is not a member of Eodiscidea.

Family PAGETIIDAE Kobayashi 1935b.

Genus **PAGETIA** Walcott 1916b.

Genotype : *Pagetia bootes* Walcott 1916b.

PAGETIA SIGNIFICANS (Etheridge fil.)

Pl. VIII, figs. 1-5.

1902 *Microdiscus significans* Etheridge Jr., p. 3, pl. 2, figs. 5-9.
1919 *Microdiscus significans* Etheridge Jr., p. 380.
1927 *Eodiscus significans* Whitehouse, p. vii.
1930 *Pagetia* Whitehouse, p. 27.
1931 *Pagetia* Whitehouse, p. 141.

Etheridge described this species in the following terms :—

" Cephalon semicircular, convex, margined by a continuous flattened limb, which is itself bordered by a raised rim, the former bearing a series of close elongated tubercles ; glabella more or less biconical, unlobed, smooth, angular in the middle line longitudinally, produced backwards as a process or spine

[26] *Delgadoia* Vogdes (1917, pp. 27 and 81), generally has been overlooked by workers on the eodiscids. *Delgadodiscus* recently proposed by Kobayashi (1935b, p. 112) is a synonym, the genotype of both being *Microdiscus caudatus* Delgado (1904, p. 349, pl. 3, fig. 12).

over the posterior cephalic margin. Axial furrows strong and wide ; cheeks tumid, smooth, well-defined by the surrounding furrows ; postero-lateral angles apparently truncate. Thorax unknown. Pygidium semicircular with a well-defined limb, and the antero-lateral angles truncated as if for facets ; axis narrow, convex, extending completely to the posterior margin of the pygidium and composed of six segments, each bearing a central blunt tubercle directed backwards ; pleurae also convex, but less so than the axis, of five segments, without tubercles or other ornament. Size of cephalon two and a half millimetres wide by two long, inclusive of the spine ; size of pygidium, three millimetres broad by two long."

The description of the material is good and the figures show the essential features of the species. Photographs of two of the types are reproduced on plate VIII of this paper.

When the species was described originally the name *Pagetia* had not been proposed ; but subsequently, in view of Walcott's description of the genus, Etheridge re-examined the original specimens. He then remarked (1919, p. 380) that he had "failed to find any trace of either 'eye line' (palpebral ridge) or eyes." To his original description he then added that "the surface of each cheek rises into a low blunt tubercle."

Etheridge's specimens were all contained in the one rock specimen that Davidson collected at Fossil Hill, 40 miles south east of Elkedra. Subsequently the species has been found in great abundance on the Templeton River. At this locality the individuals frequently reach a larger size than the forms found by Davidson ; and with the larger size there comes certain changes in features. Nevertheless I do not think that the two groups should be separated specifically.

In spite of Etheridge's statement that his specimens show no trace of eyes the margins of the cheeks of many of his specimens are broken away in the position of the facial suture of *Pagetia*. This often is so regular (e.g. on the lectotype now refigured) there can be no doubt that a true facial suture was present. The Templeton River forms show this often very clearly (pl. VIII, fig. 3).

The specimens from Elkedra and also the smaller individuals from the Templeton River show no trace of palpebral ridges or glabellar furrows ; but in the larger forms from the latter locality these features occasionally may be seen. The cephalon figured as plate VIII, figure 3 has two pairs of glabellar furrows, the anterior pair being continuous and the posterior part discrete. Also on this specimen traces of palpebral ridges may be discerned. These features are decidedly spasmodic in their development. On forms of the maximum size they are not always present. Some large specimens have neither of these features. Others have one of them, while occasionally both are present. Also they vary in intensity when they do occur.

Another feature that varies with the size of the individual is the pitting of the cephalic rim. The pits are radially elongate. In young forms they are equal ; but in older forms they are alternately long and short.

Generally the features of the species may be summarised as follows :—

The cephalon is semicircular with a conical glabella that is simple in the young forms but which, in older individuals, sometimes develops two pairs of furrows. There is a spine on the posterior portion of the glabella that overhangs the occipital furrow. The fixed cheeks join in an attenuated pre-glabellar region and become progressively more inflated from this junction towards their posterior limits. The free cheeks are narrow and occur immediately beyond the inflated edge of the fixed cheeks. The facial sutures are typically proparian, their anterior and posterior limbs being bent normal to the margin. In large specimens palpebral ridges sometimes cross the inflated fixed cheeks parallel to the posterior margin. On the rim the pittings are radial slits that are simple in the smaller forms but, with increasing age, they become alternately long and short.

There are two thoracic segments. The axis has faint median tubercles. The pleura have furrows, the sides of which are parallel to the pleural edges. The extremities of the pleura are rounded.

There are six prominent rings on the axis of the pygidium. The anterior five bear median tubercles while the sixth has a long spine that seems to have been of delicate construction for often it is broken away leaving a tubercle in its place. On each pleuron of the pygidium there are five ridges, extending obliquely from the axial rings, with their crests marked by shallow, longitudinal grooves. There is a narrow, flat rim to the pygidium, and over the posterior portion of this the axial spine projects.

There seems to be only three other described species that can be included in *Pagetia*. These are the genotype (*P. bootes* Walcott), *P. clytia* Walcott and the Indian *P. griesbachi* (Reed). Neither *P. bootes* nor *P. clytia* (Walcott 1916b, p. 408, pl. 67, fig. 2) has the pygidium furrowed as in *P. significans*, nor are the fixed cheeks inflated to such a degree. In each of these American species two pairs of glabellar furrows, similar to those that occasionally appear on *P. significans*, are sometimes present. *P. bootes* also has similar palpebral ridges. *P. griesbachi* (Reed 1915, p. 6, pl. 1, figs. 4-11) is more closely related to the Australian form. It has the same specialised types of fixed cheeks and pygidium. The only differences are that there are but four pairs of grooved pleural furrows on *P. griesbachi*, while also it is a slightly smaller form.

The specimen figured by Etheridge on plate 2, figure 7 of his paper is here chosen as the lectotype. This cephalon is refigured on plate VIII, figure 4 of the present paper. Another of Etheridge's specimens (his plate 2, figure 9) is shown on my plate VIII, figure 5.

Localities and horizon.—The lectotype and the cotypes come from Fossil Hill, 40 miles south-east of Elkreda homestead and are in the Australian Museum Collection. Other forms are from the Templeton River (University of Queensland and the Geological Survey of Queensland Collections) and also from the crossing of Buchanan's Creek, between Alroy and Alexandria homesteads (University of Queensland Collection). The horizon is the *Dinesus* Stage.

Order AGNOSTIDA Kobayashi 1935b.

So much work remains to be done on the agnostids that it is not possible to make a family review of the group. The earliest forms include among other genera *Triplagnostus*, *Diplorrhina* and *Hypagnostus* each of which may stand at the head of a separate family. *Triplagnostus* and *Goniagnostus* with their characteristic pair of glabellar furrows are related to *Solenagnostus* and *Agnostus* in which these have disappeared. Further simplification in *Agnostus* leads to *Euagnostus*. All these genera, together with ONCAGNOSTUS, gen. nov.[27] and *Fallagnostus*, I have grouped in Agnostidae. A more general simplification from this stock seems to have produced Phalacromidae in the Middle Cambrian. Smooth forms like *Phalacroma* are known also in the Lower Ordovician ; but since they occur also, although rarely, in the Upper Cambrian, I have preferred to regard these too as members of Phalacromidae. Similarly, until it can be shown that the group is polyphyletic, I place *Diplorrhina*, which begins early in the Middle Cambrian, in Geragnostidae which Howell proposed for certain Upper Cambrian forms. I do not think it necessary to multiply family names in a morphologically knit group until polyphyletic derivation is reasonably certain. Where a small group has characters that are not known to be repeated (e.g. Glyptagnostidae, Diplagnostidae, etc.) I have used family names for small natural assemblages.

Family AGNOSTIDAE McCoy 1849.

Genus TRIPLAGNOSTUS Howell 1935c.

Genotype : *Agnostus gibbus* Linnarsson 1869.

TRIPLAGNOSTUS GIBBUS (Linnarson).

(Pl. VIII, figs. 6, 7 ; pl. X, figs. 1 (pars) and 2.)

1869 *Agnostus gibbus* Linnarsson.[28]

1880 *Agnostus gibbus* Tullberg, p. 15, pl. 1, fig. 2.

1935c *Triplagnostus gibbus* Howell, p. 14, pl. 1, figs. 5, 6.

This species is extraordinarily abundant in the *Dinesus* Stage of the Templeton River where the bedding planes often are matted with the shields of the trilobite.

[27] ONCAGNOSTUS gen. nov., genotype *Agnostus hoi* Sun (1924, p. 28, pl. 2, fig. 2), has a glabella similar to *Agnostus* (s. str.) but the pygidium, which bears marginal spines, has a sack-like axis that extends to the posterior rim. This axis has two furrows and a median tubercle. *Agnostus hoiformis* Kobayashi (1933, p. 97, pl. 10, figs. 1-3) is another member of the genus.

[28] I have not had access to Linnarsson's paper and cannot quote the pagination for the species.

Professor Grönwall of Lund has kindly supplied me with some Swedish specimens of the species with which I have made a close comparison. The Queensland forms have the following features which are characteristic of *T. gibbus.*

The glabella is narrow with subparallel sides.
The transverse furrows of the second glabellar lobe are faint.
The accessory glabellar lobes are small.
The occipital spine is prominent.
The pleura of the pygidium are separated by a faint posterior furrow.
The axial tubercle of the pygidium is prominent and superimposed on the second transverse furrow.
T. gibbus and the closely related *T. hybrida* (Brögger) occur in the zone of *Conocoryphe exsulans* in Sweden.

Localities and horizon.—The species occurs in the *Dinesus* Stage of the Templeton River (University of Queensland and Geological Survey of Queensland Collections) and at the Thornton River above Thorntonia homestead (Australian Museum Collection).

TRIPLAGNOSTUS ATAVUS (Tullberg).

(Pl. VIII, figs. 8, 9; pl. X, fig. 1 (pars).)

1880 *Agnostus atavus* Tullberg, p. 14, pl. 1, fig. 1.

Triplagnostus atavus, another early member of the genus, is present in Queensland. A large number of complete specimens have been collected from Yelvertoft Station in Queensland. A noticeable feature is that the larger the specimen the more prominent are the radial furrows of the cephalon. The smallest forms are almost devoid of these grooves.

The Australian forms agree with the type (as figured by Tullberg) in the following features :—

The cephalon is ornamented with alternately long and short radial furrows.
The glabella narrows anteriorly in a very regular way.
The transverse furrows of the posterior glabellar lobe are prominent.
The accessory lobes are transversely divided by a shallow furrow.
The pygidium has no radial ornament.
The pygidial axis has the sides parallel in the middle portion, but the sides diverge anteriorly and converge posteriorly.
The axial tubercle of the pygidium is immediately anterior to the second transverse furrow.

Tullberg figured only one pygidium. On that the pleura were separated posteriorly by a longitudinal furrow. This furrow is a variable feature in the Queensland forms. On specimens on the one slab it sometimes is prominent, sometimes faint, and sometimes not present at all.

Localities and horizon.—One specimen (in the University of Queensland Collection) has been obtained from the *Dinesus* Stage of the Templeton River. Many complete specimens are in the collections of the University of Queensland and the Geological Survey of Queensland from Yelvertoft Station in Queensland. These have been presented by the owner of the station, Mr. W. Dalling. Both *Redlichia* and *Dinesus* beds are present on this property. It may be that the specimens come from the *Dinesus* beds, since the species occurs on this horizon at the Templeton River. But since it is rare at the latter locality and abundant at Yelvertoft and since in Europe it occurs in beds immediately below those with *T. gibbus*, it is possible that it may occur on some slightly earlier horizon here.

Genus **SOLENAGNOSTUS** gen. nov.

Genotype : *Agnostus longifrons* Nicholas 1915.

Diagnosis.—Agnostids very similar to *Agnostus* (s. str.) from which they differ in having a prominent, incised, post-axial furrow on the pygidium. The pygidial axis has two furrows and a median tubercle.

SOLENAGNOSTUS ACUMINATUS sp. nov.

(Pl. VIII, figs. 13-16.)

Diagnosis.—Cephalon subcircular, widest in the middle region and with a slight median embayment of the anterior margin. Rim very narrow. Glabella tapering rapidly to the front, the anterior margin acute. The length of the glabella is about two-thirds the total length. Anterior lobe triangular and relatively large, bounded posteriorly by a sharply defined furrow. Accessory lobes very small, triangular. The cheeks are moderately inflated and are separated by a sharp, narrow, pre-glabellar furrow that extends to the rim. There is no median tubercle.

The pygidium is widest at the anterior margin. Its rim is wider than that of the cephalon. The axis is lanceolate, occupying about two-thirds the length of the shield and one-third of the width. The two transverse furrows are sharp and centrally divergent. The median tubercle is on the posterior portion of the middle lobe. The post-axial furrow is prominent. Marginal spines do not appear to be present.

Remarks.—There are not many figured species that may be placed in *Solenagnostus*. *S. lundgreni* Tullberg sp. (1880, p. 20, pl. 1, fig. 8) is perhaps the closest form, having similar outlines and rims and a similarly acute glabella. However, the axis of the pygidium is wider than in *S. acuminatus* and the anterior lobe of the glabella is smaller. *S. longifrons* Nicholas sp. (1915, p. 453, pl . 39, fig. 1) has a comparably large anterior glabellar lobe but the glabella has subparallel sides and the shields generally are more elongate.

Localities and horizons.—From the *Dinesus* Stage of Yelvertoft and the *Phoidagnostus* Stage eight miles north-east of Duchess (University of Queensland Collection).

Genus **EUAGNOSTUS** gen. nov.

Genotype : *Euagnostus opimus* sp. nov.

Diagnosis.—Agnostids with the cephalon having the same features as *Agnostus* but sometimes without a pre-glabellar furrow. The axis of the pygidium is large, extending almost to the posterior rim, but it is not divided by transverse furrows. A small post-axial furrow is present on the pygidium separating the pleura.

Generally the features recall *Diplorrhina* ; but the presence of the pre-glabellar furrow in many specimens suggests that it is a separate development.

EUAGNOSTUS OPIMUS sp. nov.

(Pl. VIII, figs. 10-12.)

Diagnosis.—The individuals are large with contours and furrows (the latter well defined) in graceful curves.

The outline of the cephalon is a perfect arc of a circle. The cephalon is uniformly domed and is widest in the posterior region at about one-third of the distance from the margin. The rim gradually widens anteriorly and has a furrow of equal size behind it. The glabella narrows anteriorly but persists for about two-thirds the length of the shield. The accessory lobes are small and triangular. The furrow between the anterior and posterior lobes is shallow. The pre-glabellar furrow is short, the cheeks contracting anteriorly, leaving a median triangular space behind the rim. This furrow is shallow ; and in some specimens is not retained.

The pygidium is transversely elongate. Its axis is large, roughly equal in area to the two pleura. It has no transverse furrows, although a slight shallowing, at about one-fifth of the length from the anterior margin, suggests a rudimentary anterior furrow. Immediately behind this is a very faint tubercle. The axis extends almost to the posterior rim. The circum-axial and the post-axial furrows are deeply incised. The rim is large and in the postero-lateral corners is separated from the pleura by a slightly flattened area. Rudimentary postero-lateral spines are present.

Remarks.—Tentatively I would place in *Euagnostus* the Scandinavian *Agnostus exaratus* Grönwall (1902, p. 77, pl. 1, fig. 17). The holotype is a pygidium. Under this name Lake (1906, p. 6, pl. 1, figs. 8-10) has figured a Welsh form with cephalon attached. No pre-glabellar furrow is present in that form. In shape it differs noticeably from *E. opimus*. *Agnostus interstrictus* White (see Walcott 1886, p. 149, pl. 16, fig. 6) also appears to belong to the genus and is the form most similar to *E. opimus*.

Locality and *horizon.*—From the *Anomocare* Stage, 52 miles from Camooweal, on the road from Camooweal to Thorntonia Station (University of Queensland Collection).

Family GERAGNOSTIDAE Howell 1935b.

Howell proposed two family names Geragnostidae and Micragnostidae for agnostids without a pre-glabellar furrow and with a simple pygidial axis. This I think is an unnecessary refinement. The genera included were *Geragnostus* Howell, *Micragnostus* Howell and *Anglagnostus* Howell. If to these we add *Diplorrhina* Corda and *Peronopsis* Corda the assemblage is a group of genera, ranging from early Middle Cambrian to early Ordovician, that have many features in common. Provisionally I would set all five genera in Geragnostidae.

Genus **DIPLORRHINA** Corda 1847.

Genotype : *Agnostus sirius* Corda 1847.

DIPLORRHINA ELKEDRAENSIS (Etheridge fil.).

(Pl. IX, figs. 3, 4.)

1902 *Agnostus elkedraensis* Etheridge Jr., p. 3, pl. 2, figs. 5-9.
1919 *Agnostus elkedraensis* Etheridge Jr., p. 379.
non 1927 *Agnostus elkedraensis*, Whitehouse, p. vii.

Etheridge described this species in the following words :—

" Cephalon and pygidium of nearly equal size and shape, and more or less generally resembling one another ; whole body five millimetres long. Cephalon practically equal in length and breadth, regularly rounded in front, and the lateral margins sub-parallel ; postero-lateral angles apparently truncated ; anterior and lateral borders formed by a continuous raised limb, separated from the cheeks by a similar groove ; cheeks gently convex and smooth, rather wider laterally than anterior to the glabella ; dorsal furrows well defined and encircling an oblong, smooth, gently convex glabella, which narrows a little towards the anterior, and is traversed by one furrow, more anterior than posterior, dividing the glabella into two unequal lobes, the anterior or smaller of which bears a central small tubercle ; supplementary lobes, small and node-like, placed one on either side at the base of the glabella. Thorax very short, of one segment only, consisting of a wide axis, and tubercle-like pleurae. Pygidium resembling the cephalon in outline, with a similar raised limb and boundary furrow ; length and breadth about equal, except at the posterior end, where there is a perceptible narrowing ; incipient spines at the postero-lateral angles and along the lateral margins absent ; antero-lateral angles truncated, as if by facets ; axial lobe longer than the glabella, and approaching nearer to the posterior border of the pygidium than the glabella does to the anterior border of the cephalon, generally convex, with a central tubercle placed at the anterior end ; surface smooth, and no segmentation ; axial furrows well defined ; lateral lobes (answering to pleurae) gently convex and smooth."

No further specimens of the species have been collected, so that there is little to add to the account. There are but two aspects that need comment. Etheridge mentions that there is only one thoracic segment ; and in later remarks he infers from this that the individuals were immature. However only two complete carapaces are preserved and each of these is slightly distorted so that possibly, in the slight rotation, they partly obscure the thoracic segments.

The margin of the pygidium is uniform and Etheridge mentioned that there are no marginal pygidial spines. But in one or two specimens rudimentary spines (really angular developments of the margin) are to be seen. They can be discerned faintly on the cotype figured as plate IX, fig. 4 in the present paper. It would seem that there was an angular development from the margin projecting not laterally but ventrally and this is seen only on occasional specimens that may have been pressed somewhat obliquely on the slab.

In its cephalic features (the presence of strong circum-glabellar and intra-glabellar furrows and the absence of a pre-glabellar furrow) and also in the long, wide unfurrowed pygidial axis the species is a typical member of *Diplorrhina*. The arcuate outline of the head is somewhat more regular than in most species of the genus.

The specimen figured by Etheridge as figure 1 on his plate is chosen as lectotype and is here refigured on plate IX, fig. 3. The specimen now figured as plate IX, fig. 4 is the cotype that Etheridge showed in his second figure.

Locality and horizon.—The *Dinesus* Stage of Fossil Hill, forty miles south-east of Elkreda (Australian Museum Collection).

DIPLORRHINA NORMATA sp. nov.

(Pl. IX, figs. 1, 2.)

1927. *Agnostus elkedraensis* (non Eth. fil.) Whitehouse, p. vii.

1929 *Agnostus chinensis* (non Dames) Chapman, p. 208, pl. 21, fig. 6 ; pl. 22, fig. 20.

Diagnosis.—Cephalon subquadrate, slightly arcuate in front. Posterior lobe of the glabella sub-rectangular. The anterior lobe of the glabella, separated posteriorly by a prominent groove, is perceptibly narrower than the posterior lobe. Circum-glabellar furrow prominent. Accessory lobes very small. Cheeks U-shaped, the circum-glabellar furrow being noticeably concentric with the margin of the cephalon. Rim of moderate size bounded interiorly by a narrow prominent furrow.

There are two thoracic segments in which both axis and pleura are convex.

Pygidium sub-rectangular, relatively shorter than the cephalon. The axis is large, the lateral margins parallel and the posterior margin obtusely angular. It

reaches almost to the rim. There are no axial furrows. A small, longitudinally elongate tubercle is placed at the base of the anterior third of the axis. The pleura are narrow, converging posteriorly. The rim is slightly convex increasing in width to the postero-lateral angles where obtuse marginal spines are present.

Remarks.—Previously I had identified this form as *D. elkedraensis* (Eth. fil.); but it should be removed from that species on account of its more quadrate outline. Chapman regarded it as identical with *Agnostus chinensis* Dames; but Kobayashi (1935b, p. 102) has pointed out that Walcott (1913) grouped two distinct forms under this name. One of these he separated under the new name *Agnostus rakuroensis*. This species, which is a *Diplorrhina*, is probably the form that Chapman had in mind. *D. normata*, although particularly like *D. rakuroensis*, differs in certain minor features such as the nature of the postero-lateral regions of the pygidium and the larger size of the accessory lobes of the glabella. The Indian *D. spitiensis* Reed sp. (1910, p. 4, pl. 1, figs. 1-3) is quite different, having more rounded contours, a glabellar tubercle and a non-spinous pygidium. Among the North American species *D. montis* Matthew sp. (1899, p. 43, pl. 1, fig. 6) may be compared and also *D. acadicus* Hartt sp. (as figured by Walcott 1884b, p. 27, pl. 2, fig. 2).

Locality and horizon.—Very abundant in the *Dinesus* Stage of the Templeton River (University of Queensland and Geological Survey of Queensland Collections).

Family DIPLAGNOSTIDAE fam. nov.

It is proposed to unite in the one family the three Middle Cambrian genera *Diplagnostus* Jaekel, *Tomagnostus* Howell and *Enetagnostus* Whitehouse. In each the glabella has two primary lobes and two small accessory lobes. The anterior glabellar lobe has a median sulcus and there is a pair of medio-lateral depressions on the posterior lobe. The median sulcus of *Diplagnostus* is in the form of a furrow bisecting the anterior lobe. In *Tomagnostus* it is a small anterior structure. In *Enetagnostus* it is a depression rather than a furrow. The medio-lateral depressions of the posterior glabellar lobe are analagous in position to the furrows of *Goniagnostus* and *Triplagnostus*, but are merely rudiments.

There is a marked similarity between the pygidia of *Diplagnostus* and *Enetagnostus*. *Tomagnostus* differs in not having the divided posterior rim and in the absence of marginal spines.

Tomagnostus and *Diplagnostus* are found in the middle of the Middle Cambrian. *Enetagnostus* would appear to represent the later part of the Middle Cambrian (from the zone of *Paradoxides davidis* to the zone of *P. forschammeri*).

Genus **ENETAGNOSTUS** gen. nov.

Genotype : *Enetagnostus humilis* sp. nov.

Diagnosis.—Agnostids with well-defined circum-glabellar and transverse furrows on the cephalon, and two small, accessory glabellar lobes. Anterior glabellar lobe obtuse, with a shallow, median, longitudinal depression. Posterior glabellar lobe with a pair of shallow, medio-lateral depressions. The frontal portion of the cheek is marked by a faint longitudinal furrow. Thorax unknown. Pygidium with the rim divided in the posterior portion and with distinct or rudimentary marginal spines. Pygidial axis lanceolate, feebly trilobed, with a large, elongate, median tubercle.

ENETAGNOSTUS HUMILIS sp. nov.

(Pl. VIII, figs. 17-19.)

Diagnosis.—Cephalon moderately inflated, with a regularly curved margin rather semicircular in shape. Rim narrow, declining at the postero-lateral angles. Glabella with sub-parallel sides (very slightly contracting anteriorly) and extending for about two-thirds of the length of the cephalon. Anterior glabellar lobe subquadrate, bounded posteriorly by a shallow sulcus and bearing a median longitudinal depression. Accessory lobes small but transversely elongate. The cheeks are separated anteriorly by a shallow narrow pre-glabellar furrow.

Pygidium subquadrate with rounded posterior margin. Small postero-lateral spines are borne. Posteriorly the rim divides into two ridges enclosing a lunate area. The axis is broad and shield-shaped extending almost to the first ridge of the posterior rim. It has two pairs of discontinuous transverse furrows and bears a large though not a prominent ovate, median tubercle.

Remarks.—Comparison may be made with *E. kjerulfi* Brögger sp. (1878, p. 149, pl. 5, fig. 7), *E. arcticus* Holm and Westergaard sp. (1929, p. 13, pl. 1, figs. 26-30), *E.* (?) *vestgothicus* Wallerius sp. (1930, p. 58). The pygidium of the last-named species is most similar to that of *E. humilis*, but the cephalon is very different having radial ornament. The presence of such radial furrows makes it difficult to decide whether *E. vestgothicus* belongs to *Enetagnostus* or *Diplagnostus* ; but the strong central groove suggests the former genus. In both *E. kjerulfii* and *E. arcticus* the first ridge of the divided posterior rim of the glabella is irregular. Also the axial tubercle of the pygidium is more elongate. Westergaard (Holm and Westergaard 1929, p. 13) has pointed out that the form figured by Grönwall (1902, p. 69, pl. 1, fig. 11) as *Agnostus kjerulfii* is specifically distinct. Actually in that form there is little trace of a division in the posterior rim. Probably the Welsh form figured by Nicholas (1915, pl. 39, fig. 3) as *Agnostus kjerulfi* is the same species as that figured by Grönwall.

Locality and horizon.—From the *Phoidagnostus* Stage eight miles north-east of Duchess (University of Queensland Collection).

Family PHALACROMIDAE Corda 1847 (emend.)

Corda (1847) placed in the Phalacromides his genera *Phalacroma, Selenoptychus, Mesospeniscus, Diplorrhina, Condylopyge* and *Lejopyge*. It was an unwieldy grouping. In 1909 Jaekel erected the family Leiagnostidae for the smooth agnostids and placed in it his two genera *Leiagnostus* and *Miagnostus*. Unfortunately Jaekel quoted but ignored Corda's work, and *Miagnostus* is a synonym of *Lejopyge* (the genotype of each being *Battus laevigatus* Dalman) while morphologically *Leiagnostus* is an equivalent of *Phalacroma*. In 1913 Raymond restricted Phalacrominae to " agnostids with shields scarcely lobed " and included in it only the two genera *Phalacroma* and *Lejopyge*. He thus interpreted the sub-family in precisely the same way as Jaekel had done with Leiagnostidae. Howell recently (1935a, b) has gone a step further and has split the smooth Ordovician forms as Leiagnostidae and has recognised two families of Cambrian forms with smooth shields—Phalacromidae Corda and Platagnostidae Howell.

In the Middle Cambrian there arises a group of several genera of agnostids in which the features of the dorsal shield tend to be smoothed out. The group may be polyphyletic, the same tendency being repeated in several offshoots from Agnostidae. But, if it is polyphyletic that remains to be proved. Until such proof is available I prefer to retain the genera in the one family. Therefore I include in Phalacromidae *Cotalagnostus*, in which the tendency is incipient and mainly has affected the head, *Lejopyge* and *Platagnostus*, in which it has gone a stage further and only traces of lateral grooves bounding the axial structures remain, and *Phalacroma*[29] in which the trend has reached its acme. Possibly the tendency is polyphyletic and orthogenetic, and the Ordovician forms, indistinguishable from *Phalacroma*, may have to be removed from that genus and grouped in *Leiagnostus* as Howell has suggested. But, although in Europe, North America and Australia no smooth forms have been recorded in the Upper Cambrian to bridge the gap between the Middle Cambrian and Ordovician groups, there are smooth agnostids of this type in the Upper Cambrian of South America (Kayser, 1897 and Hoek, 1912). Therefore, until more is learnt of the range of such forms, I think it unnecessary to recognise two family groupings.

Genus **COTALAGNOSTUS** gen. nov.

Genotype : *Agnostus lens* Grönwall 1902.

Diagnosis.—A Middle Cambrian group of agnostids with smooth cephalic cheeks and with the anterior elements of the glabella very faint or absent. Usually the posterior lobe of the glabella is defined by two subparallel furrows fading out

[29] As noted below I regard *Grandagnostus* and *Gallagnostus* as synonyms of *Phalacroma*.

anteriorly ; though in some forms the outline of the anterior lobe may still be discerned. The accessory lobes are small. The pygidium has smooth cheeks and a non-spinose brim. The pygidial axis is trilobed, not extending posteriorly to the brim.

Notes.—In the genus may be placed *A. lens* Grönwall (1902, p. 65, pl. 1, figs. 8, 9), *A. frontosa* Grönwall (1902, p. 66, pl. 1, fig. 10), *A. altus* Grönwall (1902, p. 58, pl. 1, figs. 3, 4), *A. barrandei* Salter (see Lake 1906, p. 13, pl. 2, fig. 2) and *A. kushanensis* Walcott (1913, p. 101, pl. 7, fig. 7). In such an assemblage there is a gradation from forms with furrows strongly impressed and with prominent vestiges of the anterior lobe of the glabella (*C. frontosa*) to forms with very faint furrows and no trace of the anterior lobe (*C. altus*).

COTALAGNOSTUS aff. **KUSHANENSIS** (Walcott).

(Pl. IX, fig. 16.)

One Queensland specimen, an isolated cephalon, has the furrows impressed to about the same degree as *C. kushanensis*. As in that species the features of the anterior lobe can be distinguished with difficulty. A small tubercle is present on the posterior glabellar lobe.

The Queensland form is more elongate than *C. kushanensis* and has the tubercle a little more to the rear.

Locality and horizon.—*Dinesus* Stage of Yelvertoft Station. The specimen is in the collection of the University of Queensland.

Genus **PHOIDAGNOSTUS** gen. nov.

Genotype : *Phoidagnostus limbatus* sp. nov.

Diagnosis.—Smooth agnostids that differ from *Phalacroma* in retaining the accessory lobes of the glabella.

PHOIDAGNOSTUS LIMBATUS sp. nov.

(Pl. IX, figs. 10, 11.)

Diagnosis.—Cephalon smooth, subcircular with a narrow rim of variable width. At the base are two tubercles in the position of the accessory lobes of the glabella. No other glabellar structures are retained.

There are two segments in the thorax, the axis being smooth and inflated and the pleura also convex.

The pygidium is not known with certainty.

Remarks.—The only other species that may be included in *Phoidagnostus* is *Agnostus bituberculatus* Angelin (1851, p. 6, pl. 6, fig. 2). Angelin's figure shows no rim to the cephalon but a rim is mentioned in the description. Angelin's specimens

appear to be lost. Westergaard (in Holm and Westergaard 1920, p. 11) figured topotypes and also other forms of the species from Bennett Island. None of these have rims and Westergaard concludes that Angelin made a mistake in his description. The Queensland forms have definite rims and thus I have placed them in a separate species. It should be noted, however, that there is some variation in this feature. The two specimens that now are figured have rims of different widths. It is possible that the forms from Bennett Island are also specifically distinct since the only specimen figured by Holm and Westergaard is longer than the types of *P. bituberculatus*.

It may be that the pygidia that tentatively I have associated with *Phalacroma dubium* may really belong to this species. In the absence of complete specimens this cannot be decided; for the two species occur together and the only generic difference is in the cephalon.

Holm and Westergaard (1930, pp. 6, 11) have pointed out that *Agnostus bituberculatus* as pictured by Brögger differs from Angelin's species and they separate it as *Ag. confusus*. Actually it is generally distinct and is referable to *Lejopyge*.

Locality and horizon.—The *Phoidagnostus* Stage eight miles north-east of Duchess (University of Queensland Collections).

Genus **PHALACROMA** Corda 1847.

Genotype : *Phalacroma scutiforme* Corda 1847.

There is some confusion about the genotype of *Phalacroma*. Unfortunately I have not had access to Corda's work. Vogdes (1893) has summarised the paper and lists twelve species that Corda placed in *Phalacroma*. One of these is *P. nudum* Corda. Corda would appear to have consulted Beyrich's work on the Bohemian trilobites, published two years previously, in which *Battus nudus* Beyrich, a typical *Phalacroma*, is described. I have no means of deciding whether *Phalacroma nudum* Corda was intended to be the same as *Battus nudus* Beyrich. Howell (1935b, p. 227) quotes as genotype *Phalacroma nudum* without stating the name of the author of the species. Later in that year Kobayashi (1935b, p. 97) took *Phalacroma scutiforme* Corda as the genotype. Since, so far as I can discover, this was the only species of *Phalacroma* figured by Corda I have followed Kobayashi in this usage. Unfortunately in Vogdes' valuable list of trilobite genera (Vogdes 1925, p. 109), which was published after his death, a mistake has been made and the genotype of *Phalacroma* is stated to be *Calymene pulchra* Barrande, which is the genotype of *Pharastoma* Corda. Lake (1906, p. 15) and Illing (1916, p. 415) regard many of Corda's species of *Phalacroma*, including *P. nudum* and *P. scutiforme* as conspecific and identical with *Battus nudus* Beyrich. Should that be so (I am not in a position to decide) the genotype would be *P. nudum* (Beyrich).

In 1909 Jaekel, overlooking Corda's work, proposed the name *Leiagnostus* for such smooth forms. He included in the genus species from the Middle Cambrian and the Ordovician and selected as genotype the Ordovician *L. erraticus* Jaekel. Howell (1935a) has proposed to recognise both names—*Phalacroma* for the Middle Cambrian species and *Leiagnostus* for those from the Ordovician.

Howell (1935a and b) has proposed two new generic names within Phalacromidae—*Grandagnostus* and *Gallagnostus*. The first-named differs from typical *Phalacroma* merely in being larger, and Howell states that there are intermediate forms. Size seems to me to be a poor criterion, so that I am using the name *Phalacroma* to cover also the forms that Howell placed in *Grandagnostus*. *Gallagnostus*, too, is poorly characterised. The cephalic brim is as wide as that of the pygidium ; but so it is in some species of *Phalacroma* (*P. thorali* Howell). The pygidial brim is continuous anteriorly ; but this too is seen in species of *Phalacroma* (*P. ovalis* Illing sp.). I see no reason for recording *Gallagnostus* as a separate genus unless perhaps that the thoracic segments are simpler. But these are so rarely seen that it would be an inconvenient distinction.

PHALACROMA (?) **DUBIUM** sp. nov.

(Pl. IX, figs. 13-15.)

Diagnosis.—Cephalon regularly oval, prominently and regularly inflated. Surrounding it is a very narrow concave brim that grades gradually into the central part of the cephalon and is visible only in very well-preserved specimens. The posterior portion of the cephalon is truncated ; and on this portion there are faint markings akin to the outlines of the accessory lobes on *Phoidagnostus*.

The associated pygidium that tentatively is identified as belonging to this species is inflated, regularly oval, the brim increasing regularly in width from the antero-lateral angles towards the posterior. The brim is separated from the central portion of the pygidium by a groove, but it retains the general slope of the shield. This brim is not continued on the anterior margin. There is no median tubercle. Some forms show a pair of faint longitudinal grooves, limited to the anterior region, in the position of the anterior portion of the grooves of *Lejopyge*.

Remarks.—This remarkable species while generally becoming smooth as in *Phalacroma* retains faint grooves in the positions of those of *Lejopyge* and *Phoidagnostus*. It appears to be a generalised form that is difficult to place generically. I know of no other species that has these features. I think at present it is best placed in *Phalacroma*.

Among the phalacromids there is a group in which the pygidial brim, although prominent, is not flattened but retains some of the curvature of the rest of the shield and increases in width towards the posterior. In this group belong *P. nudum* Beyrich

sp. (1845, p. 46, fig. 20), *P. scanicum* Tullberg sp. (1880, pl. 2, fig. 18), *P. marginatum* Brögger sp.[30] and *P. ovale* Illing sp. (1915, p. 415, pl. 31, figs. 9, 10). Each of these forms, which have been recorded as varieties of *P. nudum* (Beyrich), bears a median tubercle on the pygidium although often this tubercle is faint. In general, apart from the faint grooves on the shields, *P. dubium* resembles this group. By its shape it may be distinguished from the other species. Also, although there seems to be a slight change in the curvature of the pygidium at the place where the tubercle normally is found, no tubercle is present. The Siberian *P. schmidti* von Toll sp. (1896, p. 5, pl. 1, figs. 5, 12, 13, 21-23) has no median tubercle and perhaps is the closest form but in that species the cephalon is subcircular. Another somewhat similar form is *P. thorali* Howell (1935b, p. 227, pl. 22, figs. 19, 20) which is somewhat nearer in shape. The Welsh *P. eskriggei* Hicks sp. (see Lake, 1906, p. 16, pl. 2, fig. 6) also has no tubercle ; but it is a circular form with a very distinctive pygidial brim. Neither of the forms from the Upper Cambrian of South America *P. boliviensis* Hoek sp. (1912), and *P. iruyensis* Kayser sp. (1897), is particularly similar.

Locality and horizon.—The *Phoidagnostus* Stage eight miles north-east of Duchess. The holotype is in the collections of the University of Queensland. There are many other specimens in this collection as well as in the Geological Survey of Queensland.

PHALACROMA SP.

A single cephalon has been found in the beds of the *Anomocare* Stage, 52 miles from Camooweal, on the road from Camooweal to Thorntonia Station (University of Queensland Collection).

Genus **LEJOPYGE** Corda 1847.

Genotype : *Battus laevigatus* Dalman 1828.

LEJOPYGE EXILIS sp. nov.

(Pl. IX, figs. 9 and 12.)

Diagnosis.—Cephalon polished, subcircular, narrowing slightly towards the front and surrounded by a narrow rim. The posterior portion is subtruncate and bears two faint furrows that, starting from the posterior margin, are convergent but disappear before they have covered one-quarter the length of the shield.

The pygidium tentatively associated with the species has a broader rim than the cephalon. The axis is represented by a slight anterior projection ; and posteriorly from this it is defined, until about the middle region of the pygidium, by faint converging grooves. The cheeks of the pygidium are smooth subtending an obtuse angle in the anterior portion so that the rim extends around the antero-lateral regions.

[30] I have not seen Brögger's paper. My information is given by Tullberg's Figure (1880, pl. 2, fig. 19).

Remarks.—The cephala referred to this species are similar in shape to those of *Phoidagnostus limbatus* and there is a tendency to confuse the two forms. The fact that some specimens have accessory lobes and some only posterior circum-glabellar furrows indicates that the two groups, similar in outline, should be separated. Several pygidia with typical, faint, circum-axial furrows confirm the presence of *Lejopyge*.

The species is more faintly furrowed than the genotype *L. laevigatus* (Dalman). Perhaps the closest form is the Norwegian *L. confusus* Holm and Westergaard sp. (1930, p. 12, pl. 4, figs. 7, 8). That species, however, has a shorter cephalon. *L. lenaicus* von Toll sp. (1896, p. 23, pl. 1, figs. 6-8, 10, 11, 14-17, 24) from Siberia has more elevated axes. The Welsh *L. barlowi* Belt sp. (see Lake 1906, p. 16, pl. 2, fig. 7) differs in the anterior features of the pygidium and in the greater persistence of the cephalic grooves. The Newfoundland species (*terranovica* and *ciceroides*) that Matthew (1896b) recorded as varieties of *Agnostus laevigatus* are probably closer to *Cotalagnostus* than *Lejopyge*.

Locality and horizon.—*Phoidagnostus* Stage eight miles north-east of Duchess (University of Queensland Collection).

Family PSEUDAGNOSTIDAE fam. nov.

I am grouping in the one family the three genera *Pseudagnostus* Jaekel (1909), *Plethagnostus* Clark (1923) and RHAPTAGNOSTUS gen. nov. This last named genus, for which *Agnostus cyclopygeformis* Sun (1924, p. 26, pl. 2, fig. 1) is selected as genotype, is very similar to *Pseudagnostus*, differing from it only in having on the pygidium an elliptical arrangement of foramina in the post-axial region, and a simple, non-spinose brim.

In *Pseudagnostus* and *Rhaptagnostus* the cephalon is of the *Agnostus* type, with an added pair of more or less prominent, discontinuous furrows in the anterior portion of the posterior glabellar lobe. There is a tendency in these forms for all furrows on the head to become indistinct. The pygidium has two axial lobes, but the furrow dividing them is usually faint and it often appears that only the one lobe is present. Occasionally, as in *Pseudagnostus orientalis* Kobayashi (1933, p. 98, pl. 9, figs. 20-22), the faint outline of the third (posterior) lobe, in the normal *Agnostus* position may be seen. The unique foraminal line of *Rhaptagnostus*, which occupies this position, thus appears to be homologous with the circum-axial furrow of the third lobe. From the postero-lateral angles of the second pygidial lobe a pair of furrows extends to or towards the brim at the mid points of the sides.

There is a most interesting homoeomorph of this family in "*Agnostus*" *securiger* Lake (1906, p. 20, pl. 2, fig. 11), which also has a pair of furrows extending from the postero-lateral angles of the second pygidial lobe to the middle points of the

sides of the brim. This species, as Lake has pointed out, is very similar in most features to *Peronopsis integer* Beyrich sp. (cf. Lake pl. 2, fig. 10) and it is clear from this relationship that the portion of the pygidium contained within the posterior furrows is merely the third lobe expanded to fill the whole posterior portion of the pygidium. That is, the furrows on "*Agnostus*" *securiger* are the ordinary circumaxial furrows of the posterior lobe, whereas in *Pseudagnostus* they form a separate feature with no recorded homologue so far as I am aware in any other agnostid.

In 1933 Kobayashi (p. 97, pl. 9, figs. 19, 23, 24 ; pl. 10, fig. 7) figured a Korean form as *Pseudagnostus cyclopygeformis* Sun. This differs from the Chinese species, as Sun (1935, p. 16) has pointed out. It has a simple pygidial brim but no foramina, and so would appear more likely to belong to *Plethagnostus*. In 1935 Kobayashi described another species, this time from Alaska, as *Pseudagnostus* (*Plethagnostus*) *clarki* Kob. This too has a simple brim. Both *P. cyclopygeformis* Kobayashi non Sun and *P. clarki* Kob. have the peculiar type of glabella in which, by the interaction of lateral and transverse furrows, there are subsidiary lobes on the front of the posterior lateral lobe. When Clark (1923, p. 124) erected the genus *Plethagnostus* he referred to it merely the genotype, *P. gyps* Clark, that was stated to be known only from the pygidium. But with this pygidium, in the Upper Cambrian boulders at Levis, Quebec, was a cephalon with the same cephalic features that are shared by Kobayashi's two species. Clark referred this to *Agnostus americanus* Billings, reproducing for comparison Billings' figures. The association of similar specialised cephala and pygidia in three widely separated regions (Quebec, Alaska and Korea) suggest that the cephalon of *Agnostus americanus* does not belong to the pygidium that Billings figured with it, but belongs to *Plethagnostus*. It should be noted that this type of cephalon is not peculiar to *Plethagnostus* but is borne also by *Pseudagnostus* (see for example the figure given by Westergaard 1922, pl. 1, figs. 7, 8). However, in some forms (*e.g. P. douvillei* Bergeron sp. and the Australian forms now recorded) the additional lobes on the glabella become very faint or disappear.

In each country, Canada, Alaska, and Korea, *Plethagnostus* is found in beds high in the Upper Cambrian, and is consistently later in age than *Pseudagnostus* and *Rhaptagnostus*.

Thus I suggest that the shields of the genera of Pseudagnostidae are differenced as follows. Each has the family characteristics of a cephalon with *Agnostus*-like furrows and, often, a third pair of glabellar furrows. These cephalic furrows frequently become very faint. The pygidium tending to become smooth has no third (posterior) lobe but has instead a pair of adventitious pleural furrows extending outwards from the postero-lateral corners of the second lobe. To these features *Pseudagnostus* adds a pair of pygidial spines. *Rhaptagnostus* which should be regarded

as a specialised offshoot, has the curious foraminal ellipse, while *Plethagnostus* retains a non-spinose pygidial rim. The continuous nature of the pleural furrows in *P. gyps* which was the feature on which Clark based his genus *Plethagnostus*, is regarded as but of specific value. *P. gyps*, with its strong furrows is at one extreme of *Plethagnostus*. At the other extreme is the relatively smooth *P. clarki* Kobayashi in which even the pre-glabellar furrow has disappeared.

Pseudagnostus is the earliest of the three genera, being found in the lowest parts of the Croixian (early Upper Cambrian). The Australian *P. vastulus* is found even as low as the top of the Middle Cambrian. *Rhaptagnostus*, known only in China, is on a rather higher level (*Kaolishania* Beds) while *Plethagnostus* is later still, being found in the uppermost Croixian of Korea (*Tsinania* Beds) and Alaska (*Parabriscoia* Beds) and in the Tremadocian (Ozarkian) of Quebec.

Pseudagnostidae is regarded as derived from Agnostidae by the suppression of a posterior pygidial lobe and the development instead of adventitious pleural furrows.

Genus **PSEUDAGNOSTUS** Jaekel 1909.

Genotype : *Agnostus cyclopyge* Tullberg 1880.

PSEUDAGNOSTUS VASTULUS sp. nov.

(Pl. X, figs. 3, 4.)

Diagnosis.—Cephalon slightly longer than broad with a regularly arcuate margin. The rim is strongly marked off from the rest of the head and is relatively broad, declining at the postero-lateral angles. The glabella has subparallel sides and is defined by a well-impressed circum-glabellar furrow. The anterior and posterior lobes are divided by a distinct groove. There is a very slight contraction of the posterior glabellar lobe at the rear of the anterior third. Opposite this is a small elongate, median tubercle. The cheeks are inflated. The pre-glabellar furrow is only faintly impressed. The accessory lobes are small and sub-equilateral.

The pygidium has approximately the same outline as the cephalon. It is regularly arched and the grooves upon it are more faintly impressed than on the head. The anterior grooves are slightly convergent posteriorly. The transverse connecting furrow is faint and has a slight curvature convex to the posterior. The lateral grooves are fainter still. Towards the rear of the anterior lobe (really the second lobe) there is an elongated tubercle through it is not very prominent. The rim is relatively flat and (as seen in a young specimen) bears small postero-lateral spines.

Remarks.—This is a relatively large species. The most similar form is the Chinese *P. douvillei* Bergeron sp.[31] which has a wider pygidial rim but otherwise agrees

[31] See particularly Monke (1902), p. 111, pl. 3, figs. 1-9, where it is recorded as *Agnostus koeferi*, and Walcott (1913) p. 100, pl. 17, figs. 3 and 8.

very well with *P. vastulus*. Most of the other species of *Pseudagnostus* in Europe and Asia, *e.g. P. cyclopyge* (Tullberg) and *P. orientalis* (Kobayashi), are easily distinguished by the more prominent second glabellar furrow although one form figured by Lake (1906, pl. 2, fig. 21) is similar to *P. vastulus* in this feature. However it is otherwise quite distinct.

Locality and horizon.—The species is abundant in the *Anorina* Stage, 4 miles north of the Twenty Mile Bore on Glenormiston (University of Queensland Collection). Two specimens have been found in the *Solenopleura* Stage of Chatsworth homestead (University of Queensland Collection).

PSEUDAGNOSTUS NUPERUS sp. nov.

(Pl. X, figs. 5-7.)

Diagnosis.—Cephalon subcircular with a prominent rim that, while distinct, is not separated by a furrow. The glabella is large, relatively narrow, and has subparallel sides. The anterior glabellar furrow is faint ; and there is, behind it, a very faint pair of depressions that represent the second furrow. The median tubercle is very long but very indistinct. The accessory lobes are relatively prominent and sub-equilateral. There is a pre-glabellar furrow that in some specimens is fairly well impressed and in others is hardly noticeable.

The pygidium has a very regular, subcircular outline and the marginal spines are very small. The rim is wide with a sulcus succeeded by a slightly raised edge. The axial and postero-lateral furrows are very faint and the pygidial tubercle is small.

Remarks.—The closest forms would seem to be *P. vastulus* and *P. douvillei* but they differ slightly in shape and, in addition, have a more robust glabella. Some comparison, particularly in glabellar features, may be made with *P. primus* Kobayashi (1935b, p. 108, pl. 14, figs. 6-10) although the two species differ considerably in outline.

On plate X two glabellae and a pygidium are figured. One glabella (fig. 7) is more inflated and has less strongly impressed grooves than the other (fig. 6) ; but they agree in other features and for the present I group them together.

Locality and horizon.—The *Elathriella* Stage at the base of the hill immediately west of Tyson's Bore on Glenormiston (University of Queensland Collection).

PSEUDAGNOSTUS cf. **CYCLOPYGE** (Tullberg).

(Pl. X, fig. 8.)

From the *Glyptagnostus* Stage 16 miles south of Glenormiston homestead a few tails of *Pseudagnostus* have been collected. These agree in general features with the genotype, *P. cyclopyge* Tullberg sp. (1880, p. 26, pl. 2, fig. 15), particularly the form figured by Westergaard (1922, pl. 1, fig. 8). They are in the collection of the University of Queensland.

Family GLYPTAGNOSTIDAE fam. nov.

It is proposed to include in this family the Upper Cambrian forms in which the pygidial axis is laterally trifid throughout its length. The glabella has well-defined anterior and posterior lobes and a pre-glabellar furrow is present.

Two genera may be placed in the family. *Glyptagnostus* gen. nov. is defined below. LOTAGNOSTUS, gen. nov. is proposed for the group of *Agnostus trisectus* Salter (1864, p. 10, pl. 1, fig. 11), a specimen figured by Westergaard (1922, pl. 1, fig. 12) being taken as the genoholotype. In this genus the glabella which is smooth has prominent anterior and posterior lobes and the accessory lobes are large. The pygidium has a pair of marginal spines. The pygidial axis has a chequered appearance due to the prominent trifid division both longitudinally and laterally. The cheeks of both cephalon and pygidium have radial and sub-reticulate ornament.

Glyptagnostus is more ornate and has a longitudinal furrow of varying prominence in the anterior glabellar lobe.

In each genus there is a tendency to develop a pair of medio-lateral depressions on the posterior glabellar lobe.

It is possible that the family Glyptagnostidae, beginning in the earlier portion of the Upper Cambrian, is derived from the Middle Cambrian Diplagnostidae. *Glyptagnostus*, the earlier of the two genera in this new family, has a median furrow or depression in the anterior lobe of the glabella, similar to that found in the members of Diplagnostidae. In the earlier family some forms of *Tomagnostus*, for example *T. perrugata* Grönwall sp. (1902, p. 50, pl. 1, fig. 1), foreshadow the typical ornament of the later group, while in some forms of *Enetagnostus*, *E. arcticus* Holm and Westergaard sp. (1930, pl. 1, figs. 26-30) for instance, the prominent, elongate tubercle of the pygidial axis suggests that the laterally trifid axis of the pygidium of Glyptagnostidae may have developed by the exaggeration of just such a feature.

Genus **GLYPTAGNOSTUS** gen. nov.

Genotype : *Glyptagnostus toreuma* sp. nov.

Diagnosis.—Cheeks of the cephalon and pygidium richly ornamented with reticulate furrows that pass laterally into radial ornament. Glabella narrow, with parallel or subparallel sides, and with the anterior lobe marked by a median, longitudinal furrow or depression. Accessory lobes small, possibly multiple. Pygidial axis transversely divided into four lobes, and divided also by furrows into three longitudinal zones. The two outer of these zones may be further subdivided. A pair of marginal spines is present on the pygidium.

Remarks.—When Jaekel (1909) erected the genus *Ptychagnostus* he based his description on the genotype, the ornate *Agnostus punctuosus* Angelin, but included within the genus other ornamented forms that did not agree in all their features with

the generic diagnosis. The groups of *Ag. trisectus* Salter (*Lotagnostus*) and *Ag. reticulatus* Angelin (*Glyptagnostus*) are now removed from this assemblage and *Ptychagnostus* is restricted to forms, like the genotype, that have divided accessory lobes on the cephalon, normal, trilobed pygidial axes but no post-axial furrow on the pygidium. These forms agree also in having incipient lateral furrows on the posterior lobe of the glabella. *Ptychagnostus* in its restricted sense is thus very close to *Triplagnostus* Howell.

In so many groups of the agnostids radial ornament is developed that it is untenable to gather into one genus all the ornate forms. *Glyptagnostus* has the most highly ornamented surface among the agnostids; but even its striking, reticulate furrows clearly have arisen from the common and recurrent radial ornament. Radial grooving, arising sporadically in independent groups, often is retricted to the cephalon. Usually these radial furrows are alternately long and short. Even in the most reticulate forms of *Glyptagnostus* there is clear trace, in the marginal areas, of radial structure based on alternating long and short furrows.

GLYPTAGNOSTUS TOREUMA sp. nov.

(Pl. IX, figs. 17-20.)

Diagnosis.—Cephalon elliptical, length slightly greater than the breadth. The glabella is narrow with subparallel sides. The anterior lobe is separated by a prominent groove that centrally has an embayment concave posteriorly; this lobe is divided by a shallow longitudinal furrow. The posterior lobe has a long but not prominent tubercle and is slightly contracted about the rear of the anterior third. Adjacent to the posterior lobe of the glabella there are lobes that may be multiple accessory glabellar lobes or else more prominent reticulation of the pleura. The pleura are of uniform width and bear, adjacent to the glabella, a series of coarse, nodose prominences due to the reticulation of the surface. A pair of such prominences extends outwards from the anterior end of the glabella, leaving in between a shallow groove that may represent the normal pre-glabellar furrow. Towards the margin the reticulations pass into regular, radial grooves, connected by secondary grooves normal to their length, while finally, immediately beside the rim, the radial ornament is resolved into alternate long and short furrows. The rim is narrow and flat.

The pygidium has a wide, long, acutely triangular axis extending almost to the rim and succeeded by a post-axial furrow. The axis has three primary lobes. The anterior axial lobe marginally bears four secondary lobes. The median axial lobe is laterally trifid (continuing the marginal division of the anterior lobe); anteriorly it bears a pair of large secondary lobes succeeded posteriorly by a flattened zone faintly subdivided into elongate sections. The posterior axial lobe is lanceolate and simple. The centre of the entire axis is raised into a type of long tubercle. The pleura have

coarse nodose prominences definitely arranged in radial series, the radii becoming alternately long and short near the margin. Each radial sector has the nodose prominences, roughly equidimensional, increasing in size towards the axis. There are about 7 primary radial sectors on each side. The rim is narrow, slightly convex and bears a pair of short spines pressed towards the margin.

Remarks.—Hitherto all members of this genus, which was known only from Europe, have been included under the name *Agnostus reticulatus* Angelin. Unfortunately many of the figures given are sketchy and do not show the full detail of the ornament. This applies particularly to the figures given by Angelin (1851), Tullberg (1880) and Gürich (1908). Also there has been disagreement among European workers on the variation of their forms. The type came from Sweden. Brögger (1882, p. 57), recording the species from Norway, stated that the Norwegian and Swedish forms differ. Lake (1906, p. 8) also notes differences in the Welsh form. However lately Westergaard (1922, p. 117), taking apparently a conservative attitude, has stated that there are no differences between these three forms. The figure that he gives, from Angelin's locality, is probably the best that yet has appeared.

I have been perplexed whether the Queensland form should be recorded as *G. reticulatus*. However all the Queensland specimens have in common certain features of the ornament that show slight differences from the Swedish form as figured by Westergaard. For instance the reticuli near the cephalon are coarser and the lateral lobes of the pygidial axis are not so minutely subdivided. For that reason I prefer to record this as a separate species.

Locality and horizon.—Very abundant in beds from 14 to 16 miles south of Glenormiston in the *Glyptagnostus* Stage (University of Queensland and Geological Survey of Queensland Collections).

? Family TRINODIDAE Howell 1935b.

It is possible that Trinodidae Howell is synonymous with Metagnostidae Jaekel. Kobayashi (1935b, p. 98) has shown that *Metagnostus* Jaekel 1909 is synonymous with *Arthrorachis* Corda 1847. Thus the name Metagnostidae must be abandoned. *Hypagnostus* is tentatively placed in the family Trinodidae.

Genus **HYPAGNOSTUS** Jaekel 1909.

Genotype : *Agnostus parvifrons* Linnarsson.

HYPAGNOSTUS VORTEX sp. nov.

(Pl. IX, figs. 7, 8.)

Diagnosis.—Cephalon subquadrate in outline, rather broader than long. Glabella, as is usual for the genus, restricted to the posterior and accessory lobes that are outlined by rather broad furrows. Posterior glabellar lobe regularly oval. This

lobe is about one-half the length of the parial portion of the cephalon and one-third the width. Accessory lobes not very distinct although relatively large.

The pygidium is subquadrate to semicircular in outline. The pygidial axis extends to the brim, separating the cheeks. The brim is prominent and without spines.

Notes.—A cephalon and a pygidium, isolated from one another, are preserved on a piece of chert with *Triplagnostus atavus* (Tullberg). No other specimens are known. In each the axial region is slightly abraded.

Hypagnostus includes a number of Middle Cambrian species, some of which are incompletely known. The genotype, *H. parvifrons* Linnarsson sp.[32] is perhaps the form most similar to *H. vortex* each species having the pygidial axis completely parting the cheeks. Of the two *H. vortex* has the more quadrate outline. The Chinese *H. latelimbatus* Lorenz sp. (1906, p. 84, pl. 4, fig. 9 ; pl. 5, figs. 10, 11) has a shorter axis, but the cheeks are divided by a post-axial furrow. *H. brevifrons* Angelin sp. (see Tullberg 1880, pl. 2, fig. 29) has a similar short axis but no post-axial furrow. *H. repandus* Holm and Westergaard sp. (1903, p. 13, pl. 1, figs. 35-43 ; pl. 4, figs. 11, 12) of which the pygidium is unknown is sharply differentiated by its peculiar, acuminate glabella. Other unnamed species have been figured by the latter authors (*ibid.*, pl. 1, figs. 3, 4) but these, known only from cephala, are rather different in shape from *H. vortex*. *H. exsculptus* (Angelin) and its variety *didymus* (Wallerius 1930, p. 58) have shorter pygidial axes. *H. umbo* Matthew sp. (1896, p. 173, pl. 1, fig. 6) from Newfoundland differs in the proportions of the cephalic features and the shape of the pygidium.

Horizon and locality.—The holotype and paratype are contained on the one specimen in the collection of the University of Queensland. This comes from the *Dinesus* Stage of Yelvertoft Station.

Family Uncertain.

Genus **ASPIDAGNOSTUS** gen. nov.

Genotype : *Aspidagnostus parmatus* sp. nov.

Diagnosis.—Cephalon subcircular, contracted posteriorly. Glabella undivided, diverging anteriorly, extending about half the length of the cephalon and rounded anteriorly. A prominent, straight, longitudinal furrow divides the pre-glabellar field. The associated pygidium has a wide axis that diverges posteriorly and extends to the posterior margin. It bears two pairs of discontinuous furrows.

[32] The figures given by Tullberg (1880, pl. 2, figs. 26-28) may represent more than one species.

ASPIDAGNOSTUS PARMATUS sp. nov.

(Pl. IX, figs. 5, 6.)

Diagnosis.—Individuals small. Cephalon subcircular, widest in the median region. The glabella is contracted at the base and rounded anteriorly. The centre portion of the glabella is raised in the manner of a large, somewhat imperfectly defined tubercle that reaches to the posterior margin but otherwise is concentric with the glabella. There are no grooves on the glabella and no accessory lobes. A straight, longitudinal furrow divides the pre-glabella field which is nearly one half the length of the shield. The cheeks are traversed by irregular, radial furrows. The rim is narrow and of uniform width.

The one pygidium associated with the glabella is contracted slightly anteriorly, the widest part being about the base of the anterior third of the shield. The axis is large, occupying about two-thirds of the pygidium. Two pairs of discontinuous, transverse furrows are present, widely spaced, dividing the axis into three subequal portions. The axis is sack-shaped, widening posteriorly, and extending to the posterior margin of the cheeks. The rim of the pygidium is slightly wider than that of the cephalon.

I know of no other species that can be placed in *Aspidagnostus.*

Locality and horizon.—From the *Elathriella* Stage at the base of the hill immediately west of Tyson's Bore on Glenormiston Station (University of Queensland Collection), three heads and one tail have been collected.

GEN. ET SP. INDET.

(Pl. X, fig. 9.)

From the *Elathriella* Stage at the base of the hill immediately west of Tyson's Bore on Glenormiston I have obtained small cephala that are very inflated but their surface features are not sufficiently well preserved for the form to be placed. The pygidium described by Walcott and Resser (1924, p. 5, pl. 1, fig. 3) as *Agnostus septentrionalis* from the Ozarkian of Novaya Zemlya has certain similar features although it is a wider type. The specimens are in the collection of the University of Queensland.

NEW GENERIC NAMES.

The names of new genera of trilobites proposed in this paper are set out below, each with its genotype.

ANORINA—*Liostracus* (?) *superstes* Linnarsson.

ASPIDAGNOSTUS—*Aspidagnostus parmatus* sp. nov.

COTALAGNOSTUS—*Agnostus lens* Grönwall.

ENETAGNOSTUS—*Enetagnostus humilis* sp. nov.

EUAGNOSTUS—*Euagnostus opimus* sp. nov.

GLYPTAGNOSTUS—*Glyptagnostus toreuma* sp. nov.

HEBEDISCUS—*Ptychoparia* (?) *attleborensis* Shaler and Foerste.

LOTAGNOSTUS—*Agnostus trisectus* Salter (genoholotype figured by Westergaard).

ONCAGNOSTUS—*Agnostus hoi* Sun.

PHOIDAGNOSTUS—*Phoidagnostus limbatus* sp. nov.

RHAPTAGNOSTUS—*Agnostus cyclopygeformis* Sun.

SOLENAGNOSTUS—*Agnostus longifrons* Nicholas.

XYSTRIDURA—*Olenellus browni* Etheridge fil.

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QUEENSLAND MUSEUM COLLECTIONS.

Topotypes of all species described in this paper, or plaster casts where only the one specimen is known, have been placed in the collections of the Queensland Museum.

BIBLIOGRAPHY.

Anderson, C., 1931. Trilobites. *Aust. Mus. Mag.*, vol. 4, No. 5, pp. 178-179.

Angelin, N.P., 1851.* Palaeontologia Scandinavica, Part 1. *Stockholm.*

Ball, L. C., 1911. The Burketown Mineral Field. *Geol. Surv. Q'land.*, Pub. No. 232.

Beyrich, E., 1845. Ueber einige böhmischen Trilobiten. *Berlin.*

Brögger, W. C., 1878. Om Paradoxidesskifrene ved Krekling. *Nyt Mag. f. Nat.*, vol. 24.

Bryan, W. H., 1928. A Glossary of Queensland Stratigraphy. *Brisbane.*

Cameron, W. E., 1901. Geological Observations in North-Western Queensland. *Ann. Rept. Dept. Mines Q'land for* 1900, pp. 186-191.

Chapman, F., 1911. On a Trilobite Fauna of Upper Cambrian Age (Olenus Series) in N. E. Gippsland, Victoria. *Proc. Roy. Soc. Vict.*, vol 23 (N.S.), pt. 2, pp. 305-324.

———— 1929. On some Trilobites and Brachiopods from the Mount Isa District, N. W. Queensland. *Proc. Roy. Soc. Vict.*, vol. 41, (N.S.), pt. 2, pp. 206-216.

Clark, T. H., 1923a. A Group of New Species of Agnostus from Levis, Quebec. *Canadian Field Nat.*, vol. 37, No. 7, pp. 121-125.

———— 1923b. New Fossils from the Vicinity of Boston. *Proc. Boston Soc. Nat. Hist.*, vol. 36, pp. 473-485.

Cobbold, E. S., 1931. Additional Fossils from the Cambrian Rocks of Comley, Shropshire. *Q.J.G.S.*, vol. 87, pp. 459-511.

Cobbold, E. S., and Pocock, R. W., 1934. The Cambrian Area of Rushton (Shropshire). *Phil. Trans. Roy. Soc. Lond.*, vol. 223, Ser. B., No. 7, pp. 305-409.

Corda, A. J. C. (and Hawle, I.), 1847. Prodrom einer Monographie der böhmischen Trilobiten. *Abh. d. k. böhm. Ges. d. Wiss.*, 5 Folge Bd. 5, pp. 129-292.

Dacque, E., 1921. Vergleichende biologische Formenkunde der fossilien niederen Tiere. *Berlin.*

Daintree, R., 1872. Notes on the Geology of the Colony of Queensland. *Q.J.G.S.*, vol. 28, pp. 271-317.

Dames, W., 1883. Cambrische Trilobiten vol. Liau-Tung. (*In "China" by Baron von Richthofen, vol.* 4), pp. 1-33.

David, T. W. E., 1927. Note on the Geological Horizon of the Archaeocyathinae. *Trans. Roy. Soc. S. Aust.*, vol. 51, pp. 410-413.

———— 1932. Explanatory Notes to Accompany a New Geological Map of the Commonwealth of Australia. *Sydney.*

Davidson, A. A., 1905. Journal of Explorations in Central Australia by the Central Australian Exploration Syndicate Ltd. *Parl. Papers South Aust.*, No. 27.

Delgado, J. F. N., 1904. Faune Cambrienne du Haut Alemtejo. *Comm. Commiss. Serv. Geol. Portugal*, vol. 5, pp. 307-374.

Denmead, A. K., 1928. A Survey of the Brisbane Schists. *Proc. Roy. Soc. Q'land.*, vol. 39, No. 7, pp. 71-106.

Dunstan, B., 1920. North Western Queensland. Geological Notes on the Cloncurry-Camooweal-Burketown-Boulia Area. *Geol. Surv. Q'land.*, Pub. No. 265.

Etheridge, R., Jr., 1897. Official Contributions to the Palaeontology of South Australia, No. 9—On the Occurrence of Olenellus in the Northern Territory. *Parl. Papers South Aust.*, pp. 13-14.

———— 1902. Official Contributions to the Palaeontology of South Australia. No. 13—Evidences of Further Cambrian Trilobites. *Parl. Papers South Aust.*

———— 1919. The Cambrian Trilobites of Australia and Tasmania. *Trans. Roy. Soc. S. Aust.*, vol. 43, pp. 373-393.

Fletcher, H. O., 1935. Trilobite Hunting in the North. *Aust. Mus. Mag.*, vol. 5, No. 9, pp. 305-312.

Gregory, J. W., 1903. The Heathcotian: A Pre-Ordovician Series and its Distribution. *Proc. Roy. Soc. Vict.*, N.S., vol. 15, pt. 2.

Grönwall, K. A., 1902. Bornholms Paradoxideslag og deres Fauna. *Danmarks Geol. Undersog.*, R. 2, No. 13.

Gürich, G., 1907. Versuch einer Neuentheilung der Trilobiten. *Centralbl. für. Min. u.s.w.*, pp. 129-133.

* My copy is the reprint of 1878.

———— 1908. Leitfossilien. Erste Lieferung: Kambrium und Silur. *Berlin.*

———— 1930. Mimaster hexagonalis, ein neuer Kruster aus dem unterdevonischen bundenbacher Dachscheifer. *Pal. Zeitschr., Bd.* 13, pp. 204-238. Also p. 315.

Hoek, H. (and Steinmann, G.), 1912. Beiträge zur Geologie und Paläontologie von Südamerika: xviii das Silur und Cambrium des Hochlandes von Bolivia und ihre Fauna. *Neu. Jahrb. f. Min.*, B. Bd. 34, pp. 176-252.

Holm, G., and Westergaard, A. H., 1930. A Middle Cambrian Fauna from Bennett Island. *Mem. Acad. Sci. U.R.S.S., Ser.* 8, *Cl. Phys.-Math.*, vol. 21, No. 8.

Howell, B. F., 1925. The Faunas of the Cambrian Paradoxides Beds at Manuels, Newfoundland. *Bull. Amer. Pal.*, vol. 11, No. 43.

———— 1935a. New Middle Cambrian Agnostian Trilobites from Vermont. *Journ. Palaeont.*, vol. 9, No. 3, pp. 218-221.

———— 1935b. Cambrian and Ordovician Trilobites from Herault, Southern France. *Journ. Palaeont.*, vol. 9, No. 3, pp. 222-238.

———— 1935c. Some New Brunswick Cambrian Agnostids. *Bull. Wagner Free Inst. Sci.*, vol. 10, No. 2, pp. 13-16.

Illing, V. C., 1916. The Paradoxidian Fauna of a Part of the Stockingford Shales. *Q.J.G.S.*, vol. 71, pp. 386-450.

Jack, R. L., 1885. Reports on the Geological Features of Part of the District to be traversed by the proposed Transcontinental Railway. *Geol. Surv. Q'land.*, Pub. No. 10.

———— 1895. Stratigraphical Notes cn the Georgina Basin, with Reference to the Question of Artesian Water. *Proc. Roy. Soc. Q'land.*, vol. 11, pp. 1-5.

Jaekel, O., 1901. Ueber die Organisation der Trilobiten. 1. *Zeit. d. deutsch. geol. Gesell.*, Bd. 53, pp. 133-171.

———— 1909. Ueber die Agnostiden. *Zeit. d. deutsch. geol. Gesell.*, Bd. 61, pp. 380-401.

Jensen, H. I., 1915. Report on the Geology of the Country between Pine Creek and Tanami. *Bull. Northern Territory*, No. 14.

Kayser, E., 1897. Beiträge zur Kenntniss einiger palaeozoischer Faunen Süd Amerikas. *Zeit. d. deutsch. geol. Gesell.*, Bd. 49, pp. 274-317.

Kobayashi, T., 1933. Upper Cambrian of the Wuhutsui Basin, Liaotung, with Special Reference to the Limit of the Chaumitian (or Upper Cambrian) of Eastern Asia, and its Subdivisions. *Jap. Journ. Geol. and Geog.*, vol. 11, Nos. 1, 2, pp. 55-155.

———— 1934. The Natural Boundary between the Cambrian and Ordovician Systems Discussed from the Asiatic Standpoint. *Rept. 16th Internat. Geol. Cong., Washington.*

———— 1935a. The Briscoia Fauna of the Late Upper Cambrian in Alaska with Descriptions of a few Upper Cambrian Trilobites from Montana and Nevada. *Jap. Journ. Geol. and Geog.*, vol. 12, Nos. 3, 4, pp. 39 57.

———— 1935b. The Cambro-Ordovician Formations and Faunas of South Chosen. Palaeontology, Part 3—Cambrian Faunas of South Chosen. *Journ. Fac. Sci. Imp. Univ. Tokyo*, sect. 2, vol. 4, pt. 2.

Lake, P., 1906. A Monograph of the British Cambrian Trilobites, Part 1. *Mon. Pal. Soc. London.*

Linnarsson, J. G. O., 1869. Om Vestergotlands Cambriska och Siluriska Aflagringar. *K. Svensk. Vet.-Akad. Handl.*, N.S., vol. 8, No. 2.

———— 1875. Tva nya Trilobiter fran Skanes Alunskiffer. *Geol. Fören. Förh.*, Bd. 2, p. 498.

Lorenz, T., 1906. Beiträge zur Geologie und Paleontologie von Ostasien unter besonderer Berücksichtigung der Provinz Schantung in China, 2—Paleontologischer Theil. *Zeit. d. deutsch. geol. Gesell.*, Bd. 59, pp. 53-108.

Matthew, G. F., 1896a. Studies on Cambrian Faunas. *Trans. Roy. Soc. Canada*, vol. 3, sect. 4, pp. 165-203.

———— 1896b. Faunas of the Paradoxides Beds in Eastern North America. No. 1, *Trans. N. Y. Acad. Sci.*, vol. 15, pp. 192-247.

———— 1899. Studies on Cambrian Faunas No. 3. Upper Cambrian Fauna of Mount Stephen, British Columbia. The Trilobites and Worms. *Trans. Roy. Soc. Canada*, vol. 5, sect. 4, pp. 39-66.

McCoy, F., 1849. On the Classification of Some British Fossil Crustacea, with Notices of New Forms in the University Collection at Cambridge. *Ann. Mag. Nat. Hist.*, ser. 2, vol. 4.

Mitchell, J., 1922. Descriptions of two new Trilobites, and Notes on Griffithides convexicaudatus Mitchell. *Proc. Linn. Soc. N.S.W.*, vol. 47, pt. 4, pp. 535-540.

Moberg, J. C., 1910. Geological Guide to Andrarum. *Geol. Fören. Förh.* Bd. 32, H. 1, pp. 45-61.

Monke, H., 1902. Beiträge zur Geologie von Schantung. 1—Obercambrische Trilobiten von Yen-Tsy-Yai. *Jahrb. d. k. preuss. geol. Landes. u. Bergakad. z. Berlin*, Bd. 23, H. 1, pp. 103-151.

Nicholas, T. C., 1916. Notes on the Trilobite Fauna of the Middle Cambrian of the St. Tudwal's Peninsula (Carnarvonshire). *Q.J.G.S.*, vol. 71, pp. 451-472.

Poulsen, C., 1923. Bornholms Olenuslag og deres Fauna. *Danm. Geol. Unders.*, 2R., No. 40.

———— 1927. The Cambrian, Ozarkian and Canadian Faunas of Northwest Greenland. *Meddel. om Gronland*, vol. 70, pp. 237-343.

Raymond, P. E., 1913. Trilobita. In Zittel-Eastman "*Text-book of Palaeontology*" (*2nd Ed.*), *London*, pp. 692-728.

Reed, F. R. C., 1910. The Cambrian Fossils of Spiti. *Pal. Indica*, Ser. 15, vol. 7, No. 1.

Resser, C. E., 1933. Preliminary Generalized Cambrian Time Scale. *Bull. Geol. Soc. Amer.*, vol. 44, pp. 735-756.

———— 1935. Nomenclature of Some Cambrian Trilobites. *Smithson. Misc. Coll.*, vol. 93, No. 5.

Ruedemann, R., 1931. Some New Middle Cambrian Fossils from British Columbia. *Proc. U. S. Nat. Mus.*, vol. 79, art. 27.

Saint-Smith, E. C., 1924. Note on the Occurrence of Cambrian Strata near Mount Isa, North-West Queensland. *Q'land Govt. Min. Journ.*, vol. 25, p. 411.

Saito, K., 1934. Older Cambrian Trilobita and Conochostraca from North-Western Korea. *Jap. Journ. Geol. and Geog.*, vol. 11, Nos. 3, 4, pp. 211-237.

Shaler, N. S., and Foerste, A. F., 1888. Preliminary Description of North Attleborough Fossils. *Bull. Mus. Comp. Zool.*, vol. 16, pp. 27-41.

Sun, Y. C., 1924. Contributions to the Cambrian Faunas of North China. *Pal. Sinica, Ser. B*, vol. 1, Fasc. 4.

———— 1935. The Upper Cambrian Trilobite Faunas of North China. *Pal. Sinica, Ser. B*, vol. 7, Fasc. 2.

Thomas, D. E., 1935. Cambrian. *Handbook for Victoria, Aust. Assoc. Adv. Sci.*, pp. 91-95.

Toll, E. von, 1899. Beiträge zur Kenntniss des sibirischen Cambrium. *Mem. l'Acad. Imp. Sci. St. Petersb.*, Ser. 8, Cl. Math-Phys., vol. 8, No. 10.

Tullberg, S. A., 1880. Om Agnostus-Arterna i de Kambriska Aflagringarne vid Andrarum. *Sver. Geol. Unders., Ser. C*, No. 42, pp. 1-37.

Ulrich, E. O., 1911. Revision of the Palaeozoic Systems. *Bull. Geol. Soc. Amer.*, vol. 22, pp. 281-680.

———— 1924. Notes on New Names in Table of Formations and on Physical Evidence of Breaks between Palaeozoic Systems in Wisconsin. *Trans. Wiscon. Acad. Sci., Arts and Lett.*, vol. 21, pp. 71-107.

Vogdes, A. W., 1893. A Classed and Annotated Bibliography of the Palaeozoic Crustacea, 1889-1892, to which is added a Catalogue of North American Species. *Calif. Acad. Sci., Occ. Papers*, No. 4.

———— 1917. Palaeozoic Crustacea. The Publications and Notes on the Genera and Species during the Past Twenty Years (1895-1917). *Trans. San Diego Soc. Nat. Hist.*, vol. 3, No. 1.

———— 1925. A List of the Genera and Subgenera of the Trilobita. *Trans. San Diego Soc. Nat. Hist.*, vol. 4, pt. 2, pp. 89-317.

Walcott, C. D., 1884a. Palaeontology of the Eureka District. In *Mon. U. S. Geol. Surv.*, No. 8.

———— 1884b. On the Cambrian Faunas of North America. *Bull. U. S. Geol. Surv.*, No. 10.

———— 1886. Second Contribution to the Studies on the Cambrian Faunas of North America. *Bull. U. S. Geol. Surv.*, No. 30.

———— 1910. Olenellus and Other Genera of the Mesonacidae. *Smithson. Misc. Coll.*, vol. 53, No. 6.

———— 1913. The Cambrian Fauna of China. *Carnegie Inst.* Pub. No. 54, pp. 1-276.

———— 1916a. Cambrian Trilobites, 3. *Smithson. Misc. Coll.*, vol. 64, No. 3.

———— 1916b. Cambrian Trilobites, 5. *Smithson. Misc. Coll.*, vol. 64, No. 5.

Walcott, C. D., and Resser, C. E., 1924. Trilobites from the Ozarkian Sandstones of the Island of Novaya Zemlya. *Rept. Sci. Results Norwegian Exped. to Nov. Zem.*, No. 24.

Wallerius, I. D., 1895. Undersökningar öfver Zonen med Agnostus laevigatus i Vestergotland. *Akad. Afh., Lund.*

———— 1930. Fran Vastergotlands Mellankambrium. *Geol. Fören. Förh.* Bd. 52, H. 1, pp. 47-62.

Westergaard, A. H., 1922. Sveriges Olenidskiffer. *Sver. Geol. Unders.*, Ser. Ca, No. 18.

Whitehouse, F. W., 1927. (Notes Accompanying an Exhibit of Fossils). *Proc. Roy. Soc. Q'land.*, vol. 39, pp. vii-viii.

———— 1930. The Geology of Queensland. *Q'land Handb. for Aust. Assoc. for Adv. of Sci.*, 1930, pp. 23-39.

———— 1931. Report of the Palaeontologist. *Ann. Rept. Dept. Mines Q'land for* 1903, pp. 141-142.

EXPLANATION OF PLATES.

PLATE VIII.

Figs. 1–5. *Pagetia significans* (Eth. fil.) (p. 81).

1. A complete specimen from the Templeton River, x. 8. (U.Q. Coll.).
2. A similar specimen from the same locality. (G.S.Q. Coll.).
3. A large head from the Templeton River, showing glabellar furrows and traces of palpebral ridges, x. 6. (U.Q. Coll.).
4. Lectotype of the species (the original of pl. 1, fig. 7 of Etheridge), x. 6. From 40 miles S.E. of Elkedra (A. M. Coll.).
5. Cotype (the original of plate 1, fig. 9 of Etheridge). Same locality (A. M. Coll.).

Middle Cambrian (*Dinesus* Stage).

Figs 6, 7. *Triplagnostus gibbus* (Linnarsson), x. 6 (p. 84).

A head and a tail from the Templeton River (U.Q. Coll.).

Middle Cambrian (*Dinesus* Stage).

Figs 8, 9. *Triplagnostus atavus* (Tullberg) (p. 85).

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Middle Cambrian (*Dinesus* Stage).

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10. A head and 11 a tail. Fig. 11 is the holotype.
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Middle Cambrian (*Anomocare* Stage).

Figs. 13–16. *Solenagnostus acuminatus* gen. et sp. nov., x. 6 (p. 86).

Two heads and two tails in U.Q. Coll. 13, 15 and 16 from the *Phoidagnostus* Stage eight miles east of Duchess. 14 from the *Dinesus* Stage of Yelvertoft. Fig. 14 is the holotype.

Figs 17–19. *Enetagnostus humilis* gen. et sp. nov., x. 6 (p. 91).

Two heads and a tail from eight miles N.E. of Duchess. Fig. 18 is the holotype. (U.Q. Coll.).

Middle Cambrian (*Phoidagnostus* Stage).

PLATE IX.

(All figures x. 6.)

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Dinesus Stage of the Templeton River (U.Q. Coll.).

Figs. 3, 4. *Diplorrhina elkedraensis* (Eth. fil.) (p. 88).
3. Lectotype (original of plate 2, figure 1 of Etheridge).
4. Cotype (original of plate 2, figure 2 of Etheridge).
Dinesus Stage 40 miles S.E. of Elkedra (A. M. Coll.).

Figs. 5, 6. *Aspidagnostus parmatus* gen. et sp. nov. (p. 105).
5. A cephalon (holotype) ; 6. A pygidium.
Elathriella Stage at the base of the hill immediately west of Tyson's Bore, Glenormiston (U.Q. Coll.).

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7. A cephalon (holotype) ; 8. A pygidium.
Dinesus Stage of Yelvertoft (U.Q. Coll.).

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9. A cephalon showing faintly the basal furrows (holotype).
12. A pygidium presumably belonging to this species.
Phoidagnostus Stage eight miles N.E. of Duchess (U.Q. Coll.).

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Two cephala each with portions of the thoracic segments attached. Fig. 10 is the holotype (U.Q. Coll.).
Phoidagnostus Stage eight miles N.E. of Duchess (U.Q. Coll.).

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Phoidagnostus Stage eight miles N.E. of Duchess (U.Q. Coll.).

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A cephalon from the *Dinesus* Stage of Yelvertoft (U.Q. Coll.).

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Glyptagnostus Stage 16 miles south of Glenormiston (U.Q. Coll.).

PLATE X.

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Dinesus Stage of the Templeton River (U.Q. Coll.) x. 8.

Fig. 2. *Triplagnostus gibbus* (Linnarsson) x. 3 (p. 84).
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Anorina Stage four miles north of Twenty Mile Bore, Glenormiston (U.Q. Coll.).

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6. A crushed pygidium.
7. A cephalon tentatively included in the species.
Elathriella Stage at the base of the hill immediately west of Tyson's Bore, Glenormiston (U.Q. Coll.).

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Fig. 9. Gen. et sp. indet. x. 6 (p. 105).
Elathriella Stage at the base of the hill immediately west of Tyson's Bore, Glenormiston (U.Q. Coll.).

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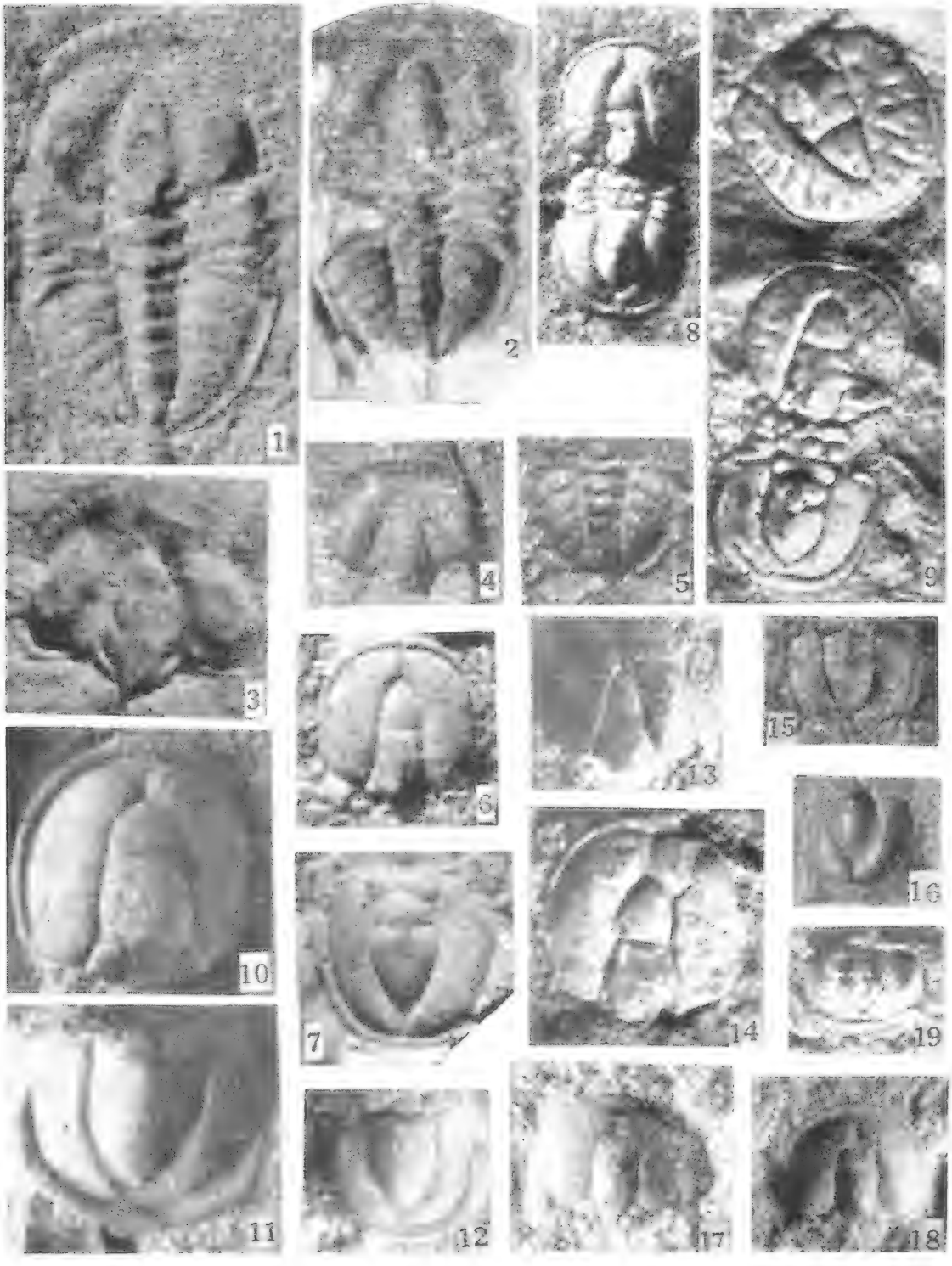
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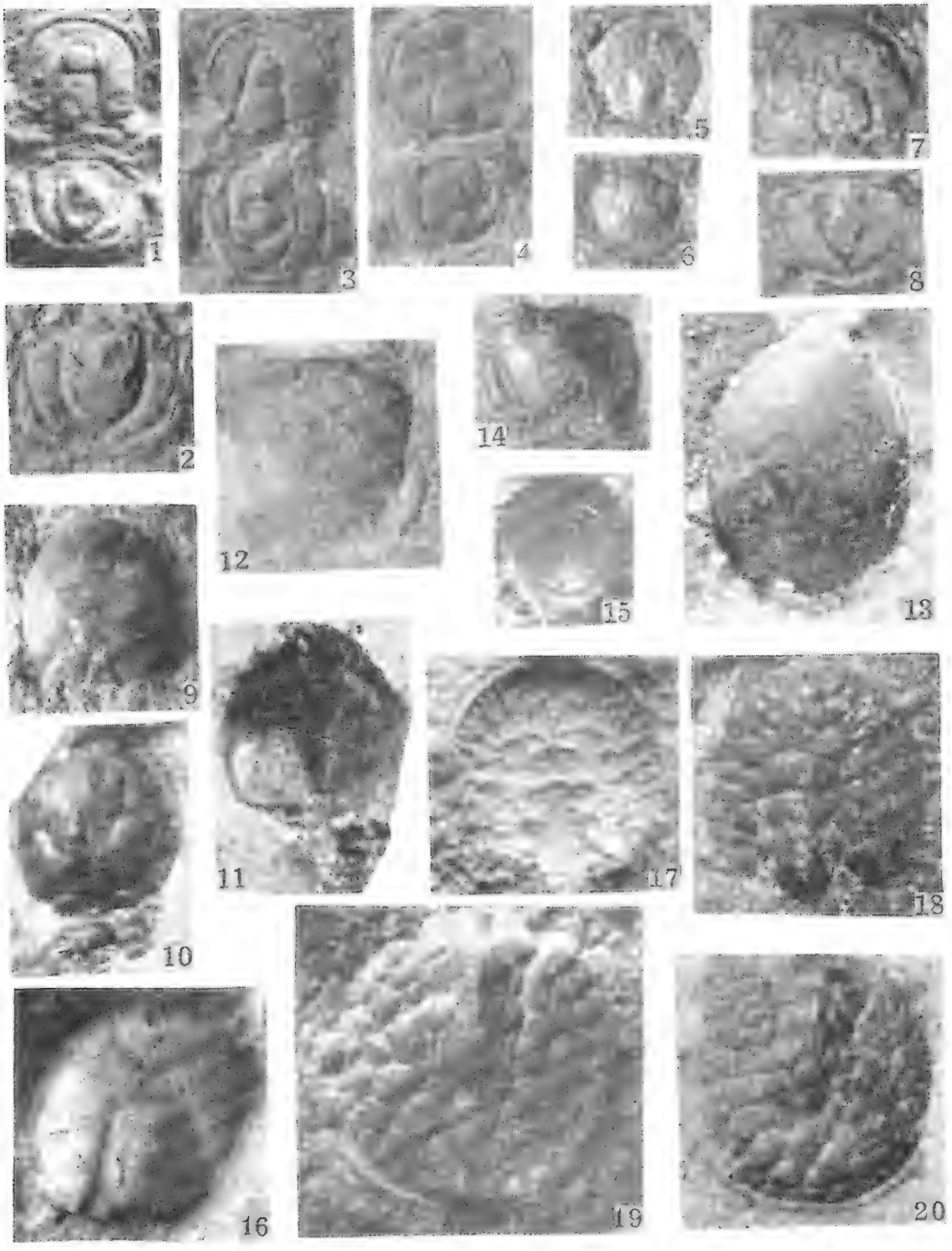
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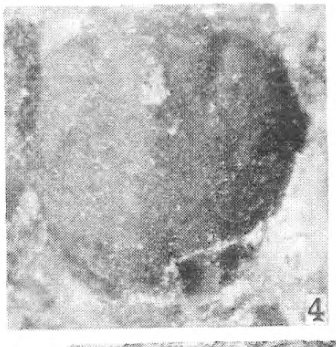
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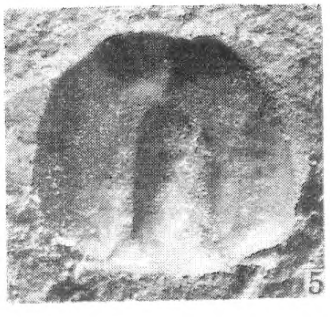
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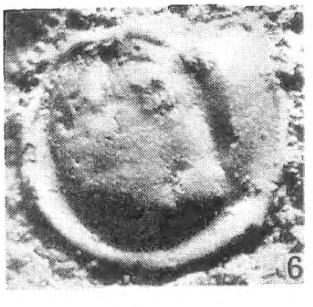
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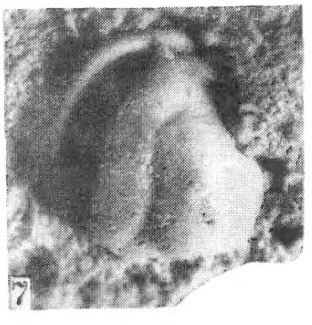
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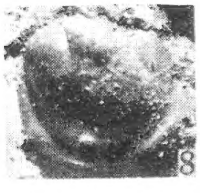
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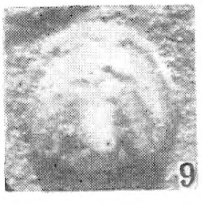
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